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TRANSACTIONS OF THE

SECTION ON

SURGERY

General and Abdominal

of the
American Medical Association
at the Seventy-First Annual
Session, held at New Orleans,
La., April 26 to 30, 1920

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PROCEEDINGS OF THE SECTION

Wednesday, April 28—Morning

The meeting was called to order at 9 o'clock by the chairman, Dr. Dean D. Lewis, Chicago.

The following papers were read as a symposium on the "Thyroid":

Dr. James T. Mason, Seattle: "One Hundred Goiter Operations: Mistakes in Retrospect."

Dr. Frank H. Lahey, Boston: "Diagnosis and Management of Intrathoracic Thyroid Growths."

Dr. Joseph R. Eastman, Indianapolis: "Advantages of Local Anesthesia in Thyroid Operations."

Dr. Willard Bartlett, St. Louis: "Technic of Thyroidectomy."

These four papers were discussed by Drs. Henry S. Plummer, Rochester, Minn.; Emil Goetsch, Brooklyn; Edward G. Jones, Atlanta, Ga.; A. J. Ochsner, Chicago; Andre Crotti, Columbus, Ohio; M. L. Harris, Chicago; G. W. Crile, Cleveland; James T. Mason, Seattle; Frank H. Lahey, Boston; Joseph R. Eastman, Indianapolis, and Willard Bartlett, St. Louis.

Dr. Joseph C. Bloodgood, Baltimore, read a paper on "Chronic Cystic Mastitis." Discussed by Drs. William C. MacCarty, Rochester, Minn., and Joseph C. Bloodgood, Baltimore.

Dr. Alfred W. Adson, Rochester, Minn., read a paper on "Brain Abscess."

Dr. George J. Heuer, Baltimore, read a paper on "Surgical Experiences with an Intracranial Approach to Chiasmal Lesions."

These two papers were discussed by Drs. H. R. Donaldson, Atlanta, Ga.; G. M. Dorrance, Philadelphia; Alfred W. Adson, Rochester, Minn., and George J. Heuer, Baltimore.

Dr. Francis Le S. Reder, St. Louis, read a paper on "Hemangioma and Lymphangioma: Their Response to the Injection of Boiling Water." Discussed by Drs. Rudolph Matas, New Orleans; Vilray P. Blair, St. Louis, and Le S. Reder, St. Louis.

Thursday, April 29—Morning

The meeting was called to order by the chairman.

Dr. Dean D. Lewis, Chicago, read the chairman's address.

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Dr. Alexander Primrose, Toronto, read a paper on "Squamous-Cell Carcinoma of the Kidney." Discussed by Drs. A. D. Bevan, Chicago; W. J. Mayo, Rochester, Minn.; J. J. Gilbride, Philadelphia; A. J. Ochsner, Chicago, and Alexander Primrose, Toronto.

The chairman appointed Drs. Wallace I. Terry, San Francisco, and Willard Bartlett, St. Louis, to serve on the executive committee in the absence of Drs. W. D. Haggard, Nashville, Tenn., and E. Starr Judd, Rochester, Minn.

Dr. William A. Downes, New York, read a paper on "Congenital Hypertrophic Pyloric Stenosis in Infants: Review of One Hundred and Seventy-five Cases in Which the Fredet-Rammstedt Operation Was Performed." Discussed by Drs. Dean D. Lewis, Chicago; Roland Hill, St. Louis; A. A. Straus, Chicago; L. T. Le Wald, New York; A. D. Bevan, Chicago; J. L. Ransohoff, Cincinnati; W. A. Downes, New York, and A. D. Bevan, Chicago.

Dr. Wallace I. Terry, San Francisco, read a paper on "Ulcer of the Jejunum Following Gastro-Enterostomy." Discussed by Drs. J. Shelton Horsley, Richmond, Va.; W. J. Mayo, Rochester, Minn.; A. J. Ochsner, Chicago; A. A. Strauss, Chicago, and W. I. Terry, San Francisco.

Dr. A. D. Bevan, Chicago, read a paper on "Surgery of Cancer of the Large Intestine."

Dr. G. W. Crile, Cleveland, read a paper on "Operation for Carcinoma of the Rectum."

These two papers were discussed by Drs. Daniel F. Jones, Boston, and W. J. Mayo, Rochester, Minn.

At the request of the chairman the session was addressed by the following distinguished guests: Col. H. J. Waring, Royal College of Surgeons, London; Dr. E. E. Desmarest, professor of surgery, University of Paris, and Dr. Jules Voncken, Liége, Belgium.

Drs. Arthur Stein and William H. Stewart, New York, presented a paper on "Roentgenologic Experience with Pneumoperitoneum." Discussed by Drs. George E. Pfahler, Philadelphia; B. H. Orndoff, Chicago, and W. H. Stewart, New York.

Dr. Walter Lathrop, Hazleton, Pa., read a paper on "Ether Oil Colonic Anesthesia." Discussed by Drs. James T. Gwathmey, New York; Alexander Primrose, Toronto; J. Shelton Horsley, Richmond, Va.; G. W. Crile, Cleveland, and Walter Lathrop, Hazleton, Pa.

Friday, April 30—Morning

The meeting was called to order at 9 o'clock by the vice chairman, Malvern B. Clopton, St. Louis.

The following officers were elected: Chairman, Dr. George P. Müller, Philadelphia; vice chairman, Dr. Edward Clarence

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Moore, Los Angeles; secretary, Dr. Urban Maes, New Orleans; delegate, Dr. R. P. Sullivan, New York; alternate, Dr. D. F. Jones, Boston.

Dr. Evarts A. Graham, St. Louis, read a paper on "Importance of the 'Vital Capacity' in Thoracic Surgery."

Dr. John L. Yates, Milwaukee, read a paper on "Prevention and Treatment of Pleurisy."

Dr. Carl Eggers, New York, read a paper on "Observations on the Relative Value of the Various Operative Procedures Employed in Acute Empyema."

These three papers were discussed by Drs. Alexander Lambert, New York; Martin B. Tinker, Ithaca, N. Y.; Arvine E. Mozingo, Indianapolis; James F. Mitchell, Washington, D. C.; Moses Behrend, Philadelphia; C. D. Lockwood, Pasadena, Calif.; George J. Heuer, Baltimore; T. T. Thomas, Philadelphia; Carl A. Hedblom, Rochester, Minn.; H. M. Richter, Chicago; Rosalie Slaughter Morton, New York; John B. Haeberlin, Chicago; E. A. Graham, St. Louis; John L. Yates, Milwaukee, and Carl Eggers, New York.

Dr. Addison G. Brenizer, Charlotte, N. C., read a paper on "The Use of Bone and Fascia Grafts in the Reconstruction of Bones and Joints."

Dr. Paul B. Magnuson, Chicago, read a paper on "Mechanic Stability of Fractures Following Operation."

These two papers were discussed by Drs. Harry M. Sherman, San Francisco; E. W. Ryerson, Chicago; W. R. Cubbins, Chicago; T. Turner Thomas, Philadelphia; Paul A. McIlhenny, New Orleans; A. G. Brenizer, Charlotte, N. C., and Paul B. Magnuson, Chicago.

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PRINCIPLES OF PERIPHERAL NERVE SURGERY *

DEAN LEWIS, M.D.
CHICAGO

Notwithstanding the amount of experimental work that has been done on peripheral nerves, there is still some difference of opinion among investigators as to their method of repair after injury or division. The complex histology of the nerve fiber and the many different processes occurring or progressing simultaneously in both segments of a divided nerve offer many opportunities for widely different interpretation of findings. If the essential features of nerve repair are understood, the factors that interfere with it can be easily determined by experimental studies or the examination of tissues removed at operation. Therefore, before discussing the principles of peripheral nerve surgery, I will consider the regeneration of peripheral nerves after division.

REGENERATION AFTER DIVISION

When a nerve is divided, definite evidences of regeneration are noted within a few hours in the proximal segment adjacent to the point of injury. Some of these early changes are undoubtedly abortive, but others indicate attempts at definitive repair. Some degenerative changes occur in the neuraxes in the distal end of the proximal segment. These do not, however, extend far back in the nerve, probably only to the next node of Ranvier.

Definitive regeneration of neuraxes occurs only in the proximal segment, and all the neuraxes that eventually

* Chairman's address.

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neurotize the distal segment passing into the motor end plates and sensory endings develop from those of the proximal segment. By the eighth day after division of a nerve, the medullated fibers of the proximal segment have given off numerous lateral rami some 5 mm. above the point of section. These grow distad beneath the old neurilemmal sheath. The nonmedullated fibers also dissociate into bundles of neurofibrillae which grow down in the old sheaths by the fourteenth day. In studying the repair of nerves through a gap, it can be positively demonstrated that no neurofibrillae can be found in the distal segment until those developing from the proximal segment have bridged the gap. Some still ardently defend the theory of peripheral regeneration of nerves, but all recent evidence shows that the theory of peripheral regeneration is based on studies made when specific stains were not in use or on experiments which were imperfectly or insufficiently controlled.

The changes that occur in the distal segment after division are equally important to those occurring in the proximal. Nerve impulses cannot be transmitted without neuraxes, but the neuraxes cannot reach their terminal distribution unless bands or conduits are formed along which these can pass or creep. Both degenerative and regenerative changes occur in the distal segment after division. The neuraxes soon become broken up. Often they seem to have snapped. Later they break up into fine granules. The myelin breaks up into balls and globules. While these degenerative changes are occurring in the neuraxes and myelin sheaths, definite evidences of growth or repair are noted in the sheath cells. The adult neurilemmal sheath (Schwann) is a fine, thin, structureless membrane provided with a few fusiform nuclei—one to each node of Ranvier, the latter varying from 80 to 900 microns in length.

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After division, the sheath cells of both the proximal and distal segments bordering on the traumatized area react early. The first indication of a growth change is indicated by a slight increase in the granular cytoplasm surrounding the nuclei of the sheath cells. This change is observed within from twenty-four to thirty-six hours after division in the cells immediately adjacent to the zone of injury. The cytoplasm increases rapidly in amount, the nuclei undergo mitosis, and by the fourth to the sixth day definite protoplasmic bands have formed. These are narrow strands or bands of protoplasm which contain hyperchromatic nuclei. This growth change, leading to the formation of protoplasmic bands, occurs throughout the distal segment. Certain factors, probably traumatic, greatly accelerate the process in those sheaths bordering on the line of division. The fully formed protoplasmic bands appear later in the peripheral parts of the distal segment than in those adjacent to the line of division.

These bands evidently play an important rôle in nerve regeneration; for the fibers which have no neurilemmal sheaths, such as those of the optic nerve and spinal cord, do not regenerate after division. Kirk and Lewis, in studying regeneration of peripheral nerves after fascial tubulization, could demonstrate these bands passing through and bridging the gap. They seemed to precede the developing neuraxes, forming pathways, as it were, for these as they developed. The neuraxes—the conducting portion of the nerve fiber—develop only from the proximal segment after division of a nerve. The changes in the neurilemmal sheath which occur throughout the distal segment and in the distal part of the proximal segment adjacent to the line of division—the so-called wallerian degeneration—are, however, essential to the definitive regeneration of the nerve; for without protoplasmic bands, which develop as a result of regenerative changes in the sheath cells, the developing neuraxes do not reach their terminal connections.

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HARMFUL EFFECTS OF SCAR TISSUE

In the repair of a divided nerve, the first consideration is to provide easy access for the developing neuraxes to the distal segment. After division of a nerve, a neuroma will develop within nineteen days. Even when there has been no hemorrhage or infection, a neuroma develops. The cut fibers retract within the epineural sheath, and a connective tissue cap forms over the end of the nerve. There is, however, a very marked attempt at repair, for the developing neuraxes as they reach the connective tissue, formed by the cells of the endoneurium and perineurium and surrounding tissues, turn back on themselves to form the spirals described by Perroncito. The neuromas which invariably form after division of a nerve, as demonstrated by Huber and Lewis, are indicative of an attempt at repair which has been thwarted by scar tissue. Some of the developing neuraxes may undoubtedly zigzag through scar tissue and reach the distal segment, but it is doubtful whether they will reach the terminal connections to which they were originally destined.

Scar tissue forming after division of a nerve interferes most seriously with nerve repair. There has been a tendency of late to advise suture by neuroma. There will be but few successes when such a procedure is attempted. In all cases the neuroma should be resected until healthy funiculi appear and to the point where scar tissue is not visible to the naked eye. In many instances even after the neuroma has been resected far back, the funiculi will have a peculiar matted, gelatinous appearance. This appearance is due to small amounts of young connective tissue, developing neuraxes and some edema. The results which have been obtained after suture would seem to indicate that successful nerve repair may be obtained when end-to-end suture is made between funiculi having this appearance.

In examining some neuromas which were resected when suture has been performed, connective tissue

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septums which equal in diameter the funiculi have been found. In such instances, it would have been easy to approximate funiculi of the distal segment with connective tissue septums of the proximal segment, thus preventing or seriously interfering with nerve repair. I believe it advisable in many cases to employ frozen sections to determine the level to which the resection of neuroma should be carried. Mobilization of the nerve segments and preparation of the nerve ends followed by accurate adjustment require some time, and the frozen sections could be easily made and studied while these procedures were being carried out.

NECESSITY OF PRESERVING THE NERVE PATTERN

Success in peripheral nerve repair depends on accurate anatomic approximation of the two ends. The importance of the internal topography of peripheral nerves should be emphasized. Stoffel has insisted that the funiculi in a mixed nerve have a fairly definite position and that the sensory and motor funiculi, which serve different muscles, maintain their position and relation throughout the entire course of the nerve. He is probably incorrect in the belief that the funiculi maintain a fairly definite relationship throughout the entire length of the nerve, for Langley has demonstrated in peripheral nerves an internal plexus. The internal plexuses apparently serve to collect together the afferent and efferent fibers of the different nerve roots for the areas supplied by the peripheral nerves, just as the brachial and lumbosacral plexuses do for the large areas supplied by the nerve trunks. In the region between the origin of two successive nerves, not arising close together, the bundles are arranged in groups which have little or no connection with one another, although the bundles forming the group are more or less interconnected. Such a region is called an intermediate region, but it gradually blends with the region in which is found the plexus which is formed by the

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interlacing of fibers or bundles given off from the nerves or bundles of the intermediate zone. Langley's work agrees with that of Dustin, who described an interlacing of nerves or bundles between the funiculi of peripheral nerves at points where branches are given off.

As far as the surgery of peripheral nerves is concerned, Stoffel's and Langley's work, although differing in detail, emphasizes the importance of nonaxial rotation of nerve trunks during suture, thus avoiding distortion of the nerve pattern. Distortion of the nerve pattern may interfere seriously with the nerve supply of muscles. If the nerve pattern is distorted, reeducation of muscles or readjustment becomes necessary. If the nerve pattern is distorted, the developing neuraxes may not reach the muscles for which they were originally intended, or neuraxes which originally served motor function may be diverted to the skin. In some instances after suture, even when care is exercised, the neuraxes may make proper functional nerve endings; but the central connections may be different from those existing before the suture was performed. In such instances a readjustment of impulses or a degeneration of these fibers must occur before coordinated movements can be made.

I have attempted without any great success to perform funicular suture. This is the object to be desired, but I believe it impossible. As perfect anatomic repair as is possible should, however, be secured in order to preserve the nerve pattern. The surgeon who makes the most perfect anatomic repair will, other things being equal, have the greatest number of successes.

It is often difficult to determine whether or not rotation has occurred or the amount of rotation, if such has occurred. This is especially true when the nerve has been divided by a missile, for the nerve after division may be rotated or displaced by the force con-

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tinuing to act. When the nerve is exposed, fine silk sutures may be inserted on both sides of the nerve before it is lifted from its bed. These serve as guides to determine the exact position of the nerve segment when suture is attempted. Mosquito forceps may be used for the same purpose, but they are not so easily handled and may cause more injury to the nerve.

If, after suture, fibers originally destined for a certain group of muscles become partly distributed to their own group and partly to those of another group, marked incoordination of movements may occur. The movements are then no longer precise. They are awkward and without force. This is often seen after suture of the radial nerve, when the supinator longus contracts more forcibly when attempts are made to use the extensors of the wrist, than when the forearm is flexed on the arm. In this instance some of the fibers which should have been distributed to the radial extensors have reached the supinator longus.

Accurate approximation will prevent to a great extent this imperfect redistribution of developing neuraxes. An imperfect redistribution occurs to some slight extent after every suture, but the results are overcome by reeducation or some degeneration of the fibers which have made wrong terminal connections.

IMPORTANCE OF EARLY SUTURE

The length of time intervening between the division of the nerve and repair is the third important factor in determining the success of nerve suture. Those cases in which nerve suture is performed early, in which the period between the injury and the operation does not exceed three or three and one-half months, have a much higher percentage of recoveries than those in which the suture is performed later. Some time ago I reviewed the statistics of nerve suture, and it seemed to me that suture performed as late as nine months after the injury presented a much lower percentage of recoveries than suture performed earlier.

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I have had the opportunity of observing eleven cases in which primary suture was performed. Nine months after suture, nine of these presented definite evidence of return of motor function. These cases could be spoken of as cured. The importance of the time element cannot be emphasized too strongly, for there is a tendency in civil practice to delay operation in hopes that improvement may occur if massage, electricity, etc., are continued long and faithfully. Supplementary movements which are not dependent on regeneration of the injured nerve are often regarded as evidences of recovery. These movements should be carefully studied, for operative interference should not be delayed because of the mistake of interpreting these movements as evidence of return of function in the paralyzed group of muscles. Early exploration is advisable in many of these cases, for the secondary changes occurring in the nerve often render suture difficult after a delay of many months, and the changes which occur in the muscles, tendons and joints may cause more or less permanent disability.

END-TO-END SUTURE

I have wished to emphasize the harmful influence of scar tissue on nerve regeneration, the necessity of preserving the nerve pattern, and the importance of early suture. These are important things in peripheral nerve surgery. The method of applying the suture in end-to-end anastomosis is simple.

End-to-end suture is the only procedure that can be relied on to reestablish the continuity and function of a nerve after division. It makes no difference concerning the suture material, for fine silk or catgut gives equally favorable results. Transfixion sutures do not seem to disturb the nerve pattern, but I believe that epineural sutures are the most satisfactory. In cases in which some traction must be exerted, it may be necessary to employ one or more transfixion sutures.

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The sutures should be applied so that the epineurium is closed, thus preventing straying of neurofibrillae in surrounding tissues. The ends should be approximated without pressure. It has been advised by some that a small gap be left. I believe that this is poor advice, although one can see the reason for it after examining neuromas which have been removed when the suture was performed. In some cases the scar tissue surrounding a funiculus equals in diameter the funiculus itself. In such cases it might be difficult to avoid approximation of the funiculi in one segment with the scar tissue in the other. If a small gap were left it might be easier for the neuraxes to find their way into the protoplasmic bands of the distal segment. Resection of the neuroma far enough back to expose healthy neuraxes is necessary if peripheral nerve suture is to be successful.

Mobilization of the segments will often permit of end-to-end suture even when the defect is long, especially when combined with displacement of the nerves and change in the position of the part. Dissection of a nerve from its bed apparently does not interfere with regeneration, for recovery within the time expected after suture occurs when, for example, the sciatic is dissected out of its bed for considerable distance. As one's experience in peripheral nerve surgery increases, the attempts at end-to-end suture even in long defects become more and more successful. In the cases in which the defect is so long that end-to-end suture is impossible, many procedures have been suggested. No one of these can be depended on to give results.

CABLE TRANSPLANTS

Experimentally, auto and homo-cable transplants will conduct neuraxes from the proximal to the distal segments. Fascial tubes can also be used with success experimentally.

The results obtained by Platt in clinical surgery when these procedures are employed are not encourag-

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ing. They suggest either that the results obtained experimentally cannot be applied directly to clinical surgery or that our technic is at fault in this work.

Platt's conclusions are as follows:

1. In eighteen operations in which fascial tubulization combined with autogenous nerve grafts, fascial tubulization alone and autogenous vein tubulization (one case) were used, there was a complete absence of any clinical sign of recovery. The shortest period over which observations were made was four months, the longest period twenty-six months.

2. Secondary exploration in four cases showed complete silence of the nerve trunk to direct faradic stimulation. End-to-end suture was accomplished in all after exsection of the bridged segment.

3. At the reexploration operations, partial or complete obliteration of the lumen of the fascial tube was noted.

4. In two specimens examined histologically, one, a tubulization alone, showed obliteration of the lumen of the tube by fibrous tissue in which no nerve fibers could be found. In the second, a graft and tubulization combined, nerve fibers were present in the center of the obliterated tube eighteen months after the operation. There was no sign of continuity between the proximal and distal ends through this strand of nerve fibers.

5. The early reexploration of all graft and fascial bridge operations is advisable.

In 120 operations I used auto cable transplants twelve times and performed tubulization with fascia six times. In none of these has there been recovery, although in two transplantations there has been some slight return of motor power in isolated muscles. The striking thing, however, is that the transplant may increase markedly in size. I believe that these cases should be explored after a reasonable time as a block to the developing neuraxes may occur at the junction

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of the transplant and the distal segment. Resection and suture at this point might favor the downgrowth of neuraxes and neurotization of the distal segment.

PROCEDURE WITH PHYSIOLOGIC INTERRUPTION

The group of nerve injuries in which there is no anatomic division but a physiologic interruption of nerve impulse offers some interesting problems. The pathology varies considerably. Constricting bands, thickened epineurium, bony callus and cicatricial nodules within the nerve resulting from intraneural hemorrhage and proliferation of intraneural connective tissues are the conditions most frequently found.

Not all are agreed as to the procedure to be followed. In some cases, however, the indications are well defined. Tinel has stated that neurolysis is permissible only when it restores a free, supple nerve, in the interior of which is found no obstacle to regeneration, and that as a whole liberation is ineffective in cases of severe lesion of nerve trunks associated with rupture of the sheath, and the development of scar tissue with the formation of a neuroma. In these cases the cicatricial tissue is either permeable to regenerating axis cylinders, in which case intervention is useless, or the obstacle does not permit of the passage of axis cylinders, and an operation such as neurolysis will not make it permeable. Neurolysis is of distinct value, but it is sometimes difficult to determine whether or not the results are the direct results of surgical intervention, for many of the patients recover spontaneously. The value of the operation cannot be denied, however, in those cases in which paralysis has existed for months and in which a distinct return of motor power occurs within ten days following the operation. Nerves which present the least macroscopic change may have the greatest alteration in or suspension of function. This is observed especially in those cases in which a number of nerves, some of which have

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recovered spontaneously, have been affected. When the operation is performed it may be found that the nerves presenting the most marked pathologic changes are the ones that have recovered spontaneously.

Whether neurolysis or resection is to be performed depends on the appearance and feel of the nerve and the electrical reaction. The time element is important in determining the results after neurolysis, that is, the time existing between the injury and the operation. Statistics dealing with a large number of nerve injuries compiled by a number of different surgeons indicate the importance of the time element. The greatest number of improvements, from 80 to 100 per cent., are noted in cases in which this operation is performed within five months after the injury. When the operations were performed eight or nine months after the injury, improvement was noted in but from 30 to 70 per cent. In thirty-nine cases in which neurolysis was performed within six months after the injury, improvement was noted in 58.9 per cent., while in 100 cases in which a year had elapsed before the operation, improvement was noted in but 28 per cent. Patients operated on ten months or more after injury had the lowest percentage of improvement. There is, however, no relation between the amount of improvement and the time at which it begins after this operation, for many of the patients who improve the most are those who begin to improve some time after operation.

Endoneurolysis, in which the separate funiculi are exposed and freed of scar tissue, is technically somewhat difficult. While there may be no increased disability as the result of such an operation—even some improvement—the end-results are usually not much of an improvement over the condition existing before the operation, for scar tissue tends to reform within the nerve.

Neurolysis is frequently combined with capsulectomy —removal of the thickened epineurium—or parallel

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incision of it. Injection of the nerve with a solution of procain, as suggested by Hofmeister, is employed by many now in preference to endoneurolysis.

A number of methods have been suggested to prevent the reformation of scar tissue after neurolysis. Whenever possible, and it is possible in the majority of cases, the liberated nerves should be placed between uninjured muscles. Even in large wounds with a great deal of scar tissue it is possible to displace muscles so that a new bed can be formed for the liberated nerve. Liberated nerves should not be placed in contact with cut muscle fibers, for the adhesions which then form may seriously interfere with the conduction of the nerve impulse.

Cargile membrane is the next choice. Fascia cannot be used for this purpose to advantage, for when placed in contact with scar tissue it becomes invaded by and converted into scar tissue. I have reoperated in three cases in which a free fat transplant has been used for neurolysis. The fat had disappeared from all, and in the place of the transplant were adhesions. These were delicate, but delicate adhesions frequently seriously interfere with nerve conduction.

RECOVERY OF FUNCTION

Following suture, nerves recover function in a fairly definite order as regards time. The musculocutaneous nerve in the arm recovers rapidly and completely. The musculospiral nerve recovers early. Distinct return of motor power in the supinator longus and radial extensors of the wrist is frequently observed within five and a half months after suture. Seventy per cent. of the cases of musculospiral suture present very definite evidences of recovery when followed for some time. Favorable results are obtained after suture at almost any level. The results are not dependent on whether the nerve is sutured above the clavicle, just above its entrance into the radial groove on the inner side of the arm, or on the outer side of the arm between

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the supinator longus and brachialis anticus. The internal popliteal (tibial portion of the sciatic) comes next in order of frequency and rapidity of recovery. A longer time is required for recovery than after suture of the musculospiral. Thirty-three per cent. or slightly more recover fair function after six months. At the end of nine months, 66 per cent. may present definite evidences of return of function. The median nerve repairs fairly rapidly and comes next in order. Contractures of the thumb and index fingers with accompanying joint changes may seriously interfere with complete restoration of function and prolong disability. In my experience the external popliteal recovers most slowly after suture. Even those patients on whom the suture is performed low down recover slowly. A large percentage do, however, recover after some time. I have observed one case of external popliteal suture in which return of function (motor) was fairly complete at the end of six months.

Peripheral nerves have great regenerative power. The procedures that are necessary to the establishment of repair are plainly indicated by clinical and experimental studies and the histologic examination of specimens. Changes occurring in muscles and joints which develop during repair unless prevented or corrected will defeat the purpose of the operation. Careful and assiduous after-treatment is necessary. There should be the closest cooperation between the physiotherapist and the surgeon. Nerve injuries occurring in civil practice should be operated on earlier than they are. Time is lost waiting for evidences of return of function. Secondary changes occurring in the nerve during this time may render the operation difficult, often unsatisfactory, and the changes which occur in the muscles and joints may increase and prolong the disability.

Early exploration after nerve injuries with loss of function of the muscles supplied by the nerve affected

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is advisable, for the condition of the nerve (anatomic division or physiologic interruption) can be determined and steps taken to promote an early return of function. Results in nerve surgery grow progressively worse with delay.

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MISTAKES IN ONE HUNDRED THYROIDECTOMIES

WITH DESCRIPTION OF A NEW METHOD OF THYROID CAUTERIZATION IN TREATING EXOPHTHALMIC GOITER *

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This series of 100 thyroidectomies for relief of toxic symptoms covers a period of eight years. The series consists of fifty-eight patients operated on for toxic adenomas, with one death, and forty-two patients operated on for exophthalmic goiter, with five deaths. During the eight year period the mortality attending surgical procedure has been markedly reduced. This reduction has been largely brought about by a fuller appreciation of our earlier errors in judgment.

TOXIC ADENOMAS

Toxic adenomas produce a sequence of symptoms somewhat different from exophthalmic goiter. There is usually no sudden exacerbation such as characterizes exophthalmic goiter, but a gradually increasing chain of symptoms over a period of many years, the symptoms beginning years after the goiter is first noted. Our histories show that the goiters were first observed in the teens or twenties and existed for several years at least before toxicity was observed.

Substernal goiter was found in six patients, all showing thyrotoxic and pressure symptoms. All these cases were adenomatous, which, with other studies, leads us to believe that all substernal goiters are adenomatous and sooner or later become toxic.

* From the Mason-Blackford-Dowling Clinic.

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Secondary operations were necessary on six patients because of recurring symptoms associated with considerable enlargement of that portion of the thyroid left at the previous operation. Immediate improvement was noted following the first operation for a period averaging two years; then within a few months the symptoms became nearly as marked as before the first operation.

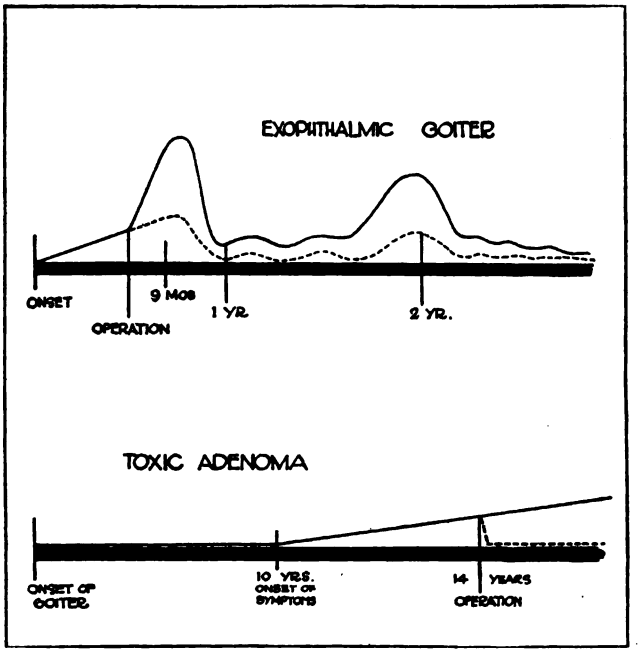

Fig. 1.—Exophthalmic goiter: Base line, normal health; curved line above, intoxication of patient who has not been operated on; dotted line, intoxication of patient following operation. Toxic adenoma: Base line, normal health; line above, gradual increasing intoxication of patient; dotted line, operation.

Rest and medical treatment preliminary to operation should be undertaken in bad cases to get the patient into reasonably good physical shape. After such preliminary treatment we remove most of the thyroid gland. These operations can usually be done under morphin and local anesthesia. The patients sit up on the

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third day and leave the hospital at the end of one week, provided the cardiac condition is reasonably good.

Postoperative results were ascertained by inquiries sent out in January, 1920. More than half the patients answered. All reported themselves cured or improved and as having regained their normal weight. Their general health was vastly better, and they were all greatly pleased with the operative result. In fact, there is no group of surgical cases in which the end-results are more satisfactory than in thyroidectomy for toxic adenomas. Bad judgment was manifestly exercised as we look back at certain cases.

In our fifty-eight cases only one was lost. This death occurred in a Christian scientist who requested operation, but refused the preliminary treatment necessary to get her into good physical shape. The poor judgment in operating under these circumstances was inexcusable.

We operated immediately on a few patients who urgently needed preliminary medical treatment. While only one death resulted, we have had some very stormy postoperative days that could have been avoided.

In the first years we exercised bad judgment in not operating on a few extremely ill patients, usually because of bad hearts. We now regard no toxic adenoma patient as too poor a risk to put at rest under observation, with a view to thyroidectomy. Even the worst cases can usually be tided over a thyroidectomy. If thyroidectomy can be performed there is great subsequent improvement in the patient's general and cardiac condition.

Recurrence of goiter and toxic symptoms seems to indicate that we have occasionally removed too little of the thyroid, so our present tendency is to remove more rather than less. No bad results have followed this plan.

EXOPHTHALMIC GOITER

Exophthalmic goiter, with few exceptions, runs a typical course, as has been recently confirmed by

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Blackford in studying our cases. Had we known in the early years the usual course of this disease, our mortality would have been lower.

The typical case shows a slight thyroid enlargement with mild toxic symptoms, during several months. The symptoms gradually increase until about the eighth month, when they become markedly worse. During the ninth month there is an explosion of symptoms, commonly known as a crisis. Then there is a period of improvement, with fairly constant symptoms. At about the end of the second year a second crisis occurs, never quite so severe from the standpoint of toxicity as the first. After this there are ups and downs until, after years, the toxicity of the goiter wears out and we have occasionally a cure, but usually a human wreck, suffering from cardiac and general degenerations.

Early in the disease it may be difficult to make a diagnosis of hyperthyroidism. The basal metabolism rate will be of great assistance at this period, because it assures the diagnosis and enables us to urge surgical interference at the time when most benefit can be secured. The heart, liver and kidneys have not been damaged; the operative risk is good; the end-results are better than at any other time during the course of the disease.

Unfortunately, if the patient is put completely at rest and given any medicine or none, there is a temporary improvement. This temporary improvement, and the rapid improvement which occurs following the crisis, has caused many drugs to be considered specific; and much valuable time has been lost to patients because this improvement has been credited to the medicine. Thus, good surgical risks have been permitted to become extremely poor ones. Should the patient be allowed to go through the usual course of the disease, there is such marked change in the vital organs that it is impossible by surgical interference to secure more than a relative cure.

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The ideal time for operation is within the first six months. The closer we get to the high wave of toxicity, the higher is the mortality and the larger the number of incomplete cures. The patient operated on before the first crisis is eventually much better off than the one who is carried to and then through the crisis by medical treatment and operated on later. However, the patient who is operated on early in the disease will have a slight wave of toxicity at the time of the first crisis; but the severity of this wave will be reduced in proportion to the fraction of the gland removed. If four fifths of the thyroid has been removed, the subsequent crisis will be one-fifth as severe.

In extremely toxic cases it is impossible to tell how much operative interference will be tolerated. As a rule the patient's history and general condition, the pulse and pulse pressure and the metabolic rate give an index to the degree of intoxication. But the shock or acute exacerbation of symptoms following operative procedure is not always as expected. Sistrunk says that of two patients with a plus 50 metabolic rate and other findings about the same, one may stand thyroidectomy well, while the other will prove to be a poor surgical risk. In other words, we have no accurate way of determining the amount of damage already done, although our findings on the present activity of the gland may be fairly accurate.

Postoperative results have been reported by three fourths of our exophthalmic goiter patients. They are all improved, and most of them feel that they are well. Two are still marked cardiopaths. A third is an inmate of a hospital because of degenerative changes dating back to the first high wave of toxicity. These three exemplify the cases which we so often see following exclusive and persistent medical treatment; the hyperthyroidism has disappeared, but the degeneration of vital organs persists.

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Secondary operations have proved necessary on five of our exophthalmic goiters. In these five cases there were remarkably severe reactions following thyroidectomy. This observation, with other experience, leads us to believe that there is less reaction if a very large part of the gland is removed.

Lack of judgment as to the best time for interference and the best type of operation on exophthalmic goiter has given us much grief—in fact, we feel that our most serious mistakes have been due to lack of a full appreciation of the dangers of the crisis of the disease and by attempting too much in extremely bad cases. Three of our deaths, even now, appear to me to have been unavoidable, but the other two patients would now be treated more conservatively. While anxiously watching the first three days of a stormy convalescence, we have often wished that a less complicated operative procedure had been undertaken.

In operative procedures in bad exophthalmic goiter cases we use little general anesthesia. In all such recent cases, operations have been performed under local anesthesia, a little ether occasionally being used when it becomes necessary to pull on the gland.

There are a few patients who are such poor surgical risks that we wonder whether anything surgical can be attempted. We have kept them at rest and under medical treatment until maximum improvement is attained, and then have depended on the injection of boiling water or ligation of one superior thyroid artery to secure further improvement.

Injection of boiling water may give an idea of the reaction of the patient, but it destroys no portion of the gland. Ligation will often precipitate a severe attack of hyperthyroidism. There is almost always reaction; this is especially true following ligation. The collateral circulation is unquestionably restored within a few days, which leads us to believe that the improvement following is largely due to an increasing immu-

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nity to the disease resulting from these high waves of toxicity.

We all agree that the symptoms subside as soon as the gland is safely removed. Then in these bad cases our ideal surgical treatment leading to thyroidectomy should theoretically destroy or remove a small portion of the goiter, with little or no reaction from the patient. Theoretically, this removal or destruction of a portion of the gland should be painless; it should be very simple; it should give no reaction.

Actual cauterization of the exophthalmic gland has been done during the last two years in a few cases, and has apparently approached this theoretically perfect surgical treatment. It is so simple and so painless that it can be performed without the patient's being conscious of what is going on. Reaction has been negligible. The results have been excellent.

TECHNIC AND COMMENT

Local anesthesia is begun by pressure for thirty seconds to the point chosen for the first needle puncture of a cotton applicator frozen with ethyl chlorid. Thus we are able to introduce the first needle without pain. Careful infiltration with procain is then made in the usual manner. An incision 2 cm. long is made just to the inner side of the sternomastoid muscle, in the line where the thyroidectomy incision will later be made. The skin, platysma and fascia are divided in the same direction; these tissues are pulled back with small retractors, and the underlying muscles split with blunt scissors. When the goiter is exposed, the retractors are inserted down to the gland. By slight traction the fibrous capsule can be separated from the anterior surface of the gland, exposing the peritoneal-like membrane over a space the size of a dime. The field is made dry. Then an electric cautery, while cold, is passed through the incision down to the anterior surface of the gland. The current is turned on and the cautery rocked slowly from side to side, a piece

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of gland about the size of a shoe button being destroyed, and causing coagulation of a much larger area. No sutures are inserted, but two or three clips are used for closing the skin. Petrolatum is applied to the outside of the wound to prevent the first dressing from sticking.

There is usually a little muscular soreness at the first dressing, but otherwise we have experienced no local reaction. There has been no hemorrhage, sepsis or sloughing, and there has been no unusual difficulty in performing subsequently a thyroidectomy.

This procedure may be repeated every few days, destroying larger portions of the gland until the patient is considered a safe risk for ligation or thyroidectomy. Further incisions are made 2 cm. apart, care being taken to keep them in the same line as the future collar incision for thyroidectomy. The usual collar incision later will manifestly obliterate all external evidence of the cauterization.

In a few recent cases we have used the fractional cauterization in place of ligation. If this method proves as efficient as it seems to be, it may enable us to do away with the reaction and unsightly scarring of ligation.

Surgical mortality in exophthalmic goiter will always be higher than in other types of goiter, because of the nature of the disease. Yet, by taking these patients through a series of minor operative procedures, it is surprising how many can be relieved without a death.

For years it has seemed desirable that we destroy or remove a small part of the exophthalmic goiter gland in extreme cases, with minimum shock to the patient. In a few cases our method has given results exceeding expectations. We commend it to you to test and to pass upon.

CONCLUSIONS

1. All patients suffering from toxic adenomas or exophthalmic goiter are surgical cases.

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2. Preliminary rest and medical treatment are essential to a low mortality risk in bad cases.

3. Poor end-results are usually due to operation undertaken after the onset of permanent degenerations in vital organs.

4. Fractional cauterization of the gland in bad exophthalmic goiter cases has proved efficient, either as preliminary treatment to ligation or in replacing ligation.

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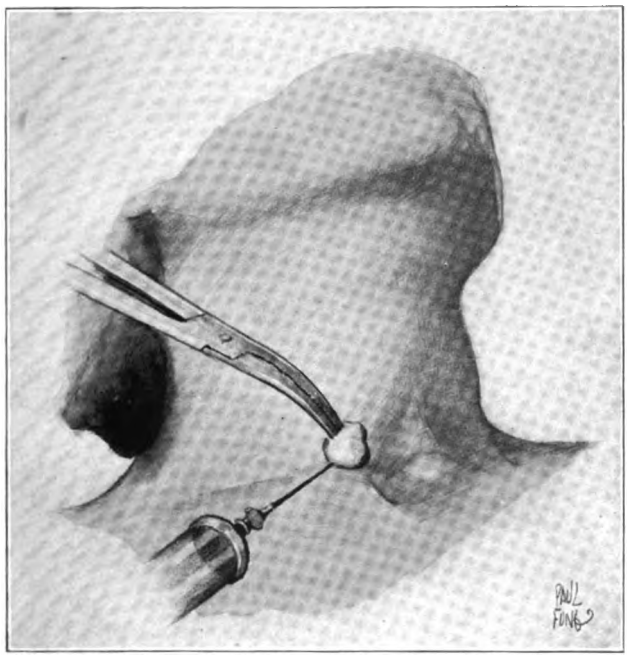

Fig. 2.—A piece of cotton is frozen with ethyl chlorid and held on the neck for thirty seconds. A needle can be inserted under this without pain and without the patient's knowledge of what is being done.

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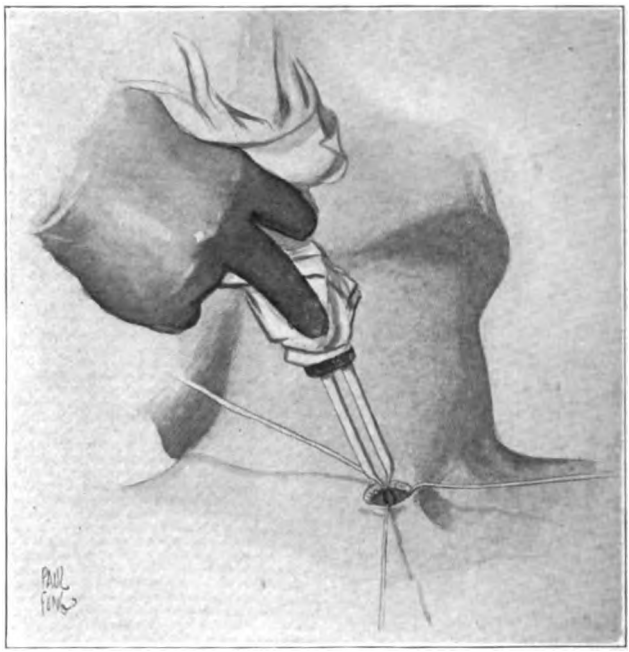

Fig. 3.—The skin, platysma and fascia have been severed. Separation of muscles with blunt scissors.

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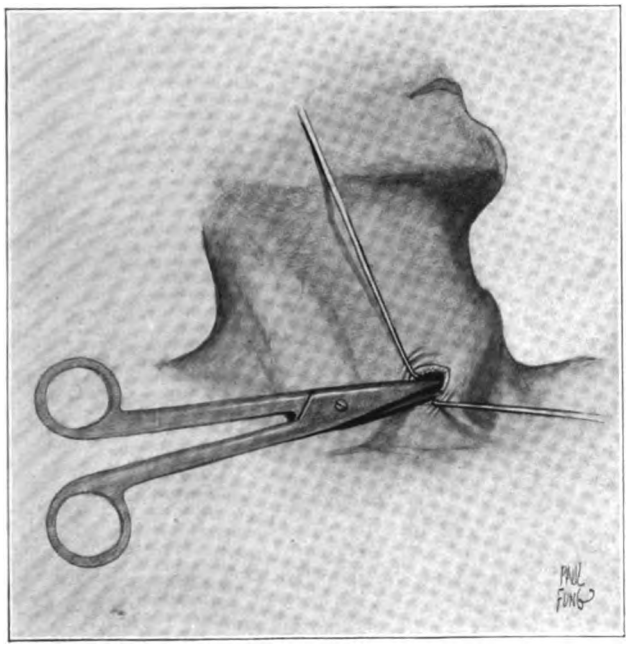

Fig. 4.—Cautery being applied to gland.

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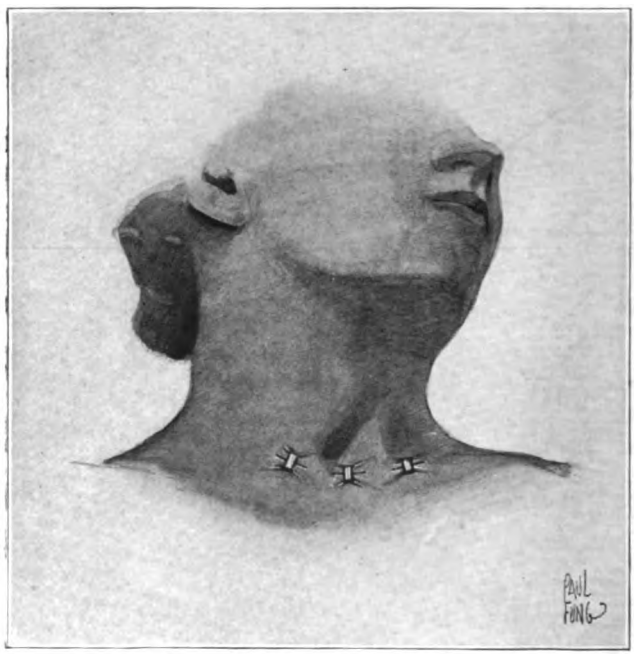

Fig. 5.—Patient who has had three fractional cauterizations.

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DIAGNOSIS AND MANAGEMENT OF INTRATHORACIC GOITERS

FRANK H. LAHEY, M.D.
BOSTON

The following remarks are based on an operative experience with four completely intrathoracic adenomas of the thyroid, one large completely intrathoracic thyroid cyst, and sixty substernal or incompletely intrathoracic thyroid growths, varying in the depth of their locations from almost completely intrathoracic goiters to slightly substernal adenomas or colloid goiters.

It is my opinion that too little attention has been directed to intrathoracic goiter, which may be so satisfactorily operated on, and so plainly diagnosed, if its presence is recognized before its growth has reached proportions which threaten life by obstructing respiration, or preclude removal because of the extent of its diameters.

Concealed thyroid growths occur as two types, namely:

1. Those completely intrathoracic, in which no part of the goiter is visible or palpable, or in which just the uppermost part is barely palpable in the sternal notch. This group is made up of adenomas or cysts of the thyroid.

2. Those incompletely intrathoracic, in which the major portion of the goiter is on the neck, and easily visible; its lower pole being substernal, subclavicular or intrathoracic. This type is made up of adenomatous, cystic or colloid goiter; and in connection with the latter (colloid), I wish to remark on the fre-

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quency, in my experience, of calcification in this type of enlargement of the portion situated within the chest.

The location and anatomy of the thyroid gland are such that one would expect that all enlargements of the thyroid reaching any size would be directed downward in their growth; whereas, in fact, the growth of such enlargements is commonly directed forward.

The influences that tend to direct the progress of growth in cysts, adenomas and colloid enlargements inferiorly are as follows:

First, the enlargement is constantly subjected to pressure anteriorly by the anterior group of neck muscles—sternothyroid, sternohyoid, omohyoid and sternocleidomastoid. It must be borne in mind that inferiorly no supporting structures offset the results of this anterior pressure, since the inferior boundary of the thyroid is the open upper thoracic aperture; so that when no antagonistic influences are present, such as adhesions of the growth to the trachea, or attenuation on the part of this group of anterior neck muscles, the tendency must be seriously to influence the direction of growth downward.

A further factor favorable to intrathoracic growth is that the thyroid and its contained tumor or cyst ascend and descend with swallowing, a condition which influences the tumors or cysts situated in the lower poles or in the isthmus of the gland constantly to mold for themselves a bed ever enlarging downward with the increase in size of the cyst or tumor. In this connection, also, one recalls the fact that the deeper of the two anterior neck muscles, the sternohyoid, is inserted, not into the top of the sternum, but over the top and downward into the posterior surface so that it acts in a guiding capacity in directing growths from above downward within the thoracic cavity.

The foregoing are the principal factors that influence the downward extension in certain instances of

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thyroid enlargements of the variety already mentioned, and these factors in large part bring about the condition spoken of as Group 2, incompletely intrathoracic goiters, or substernal or subclavicular goiters.

Group 1, the completely intrathoracic goiters, however, require still another influence to bring about their development.

An adenoma or cyst lying free in the thyroid, for example, is directed downward by the influences already spoken of, until it is a true substernal or incompletely intrathoracic goiter. To become then completely intrathoracic, the diameter of the tumor itself must increase; and whether it becomes completely or but partially intrathoracic depends on whether the axis diameter is below the level of the top of the thorax, or above it. If above, it will enlarge upward. If below, owing to the fact that the thoracic cage narrows in approaching its upper aperture, as shown in the illustrations, with increase in axial diameter, there will be, because of the outflaring walls of the chest, a gradual descent of the tumor into the thoracic cavity. This, I believe, is the mechanism of most cases of completely intrathoracic thyroid growths.

If the foregoing assumptions are true, why is it that so few of the adenomas and cysts become completely or incompletely intrathoracic?

Two factors, already mentioned, play a large part in preventing this condition.

The first factor is the great variation in the development of the anterior neck muscles, particularly the sternohyoid and sternothyroid. One who operates frequently for hyperthyroidism—a condition of the thyroid which virtually does not affect this pair of muscles at all—cannot fail to be impressed with the apparent attenuation in these muscles in a great number of cases, and in such cases the important factor of anterior pressure must be largely lost. Clinically,

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either as cause or effect, one frequently observes attenuation, and often almost entire fibrosis of the longitudinal muscles over the adenomas and cysts of the variety that has enlarged anteriorly.

The other factor is the firm adherence to the trachea of many of the anteriorly enlarging types of thyroid growths, a clinical fact that all thyroid operators cannot fail to have observed—adhesions that are firm and supporting, and doubtless play a considerably antagonistic part toward the influences directing downward growth.

As regards the evidence of intrathoracic goiter, this type usually reveals itself by various degrees of respiratory obstruction, dependent on the progressive growth of the adenoma or cyst. It has been my experience, too, that periodicity of attacks of respiratory obstruction has been quite constant, and it is probably because of these periodic attacks of dyspnea that several of the cases of intrathoracic goiter have been treated for a long time, by various medical and surgical measures, for asthma. The labored breathing that accompanies the attacks simulates asthma in that the respiratory effort is marked; but in no other way does it resemble it.

Roentgen-ray examination demonstrates the substernal shadow continuous above, and as a distinct widening of the upper sternal shadow. A feature that is of even greater diagnostic value is the bowing or deviation of the trachea, as shown by the roentgenogram. This takes place when the adenoma or cyst grows from one side; but when it is bilateral in growth—as occurred in one case—the trachea is then not deviated, but collapsed from before backward. When deviation is demonstrated by the roentgen ray, there can be little doubt as to the existence of an intrathoracic growth. On fluoroscopic examination, ascent and descent are of value in differentiating these from other mediasternal growths which do not move. Since

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Fig. 1.—Course of deviated trachea (indicated by arrows) and intrathoracic shadow.

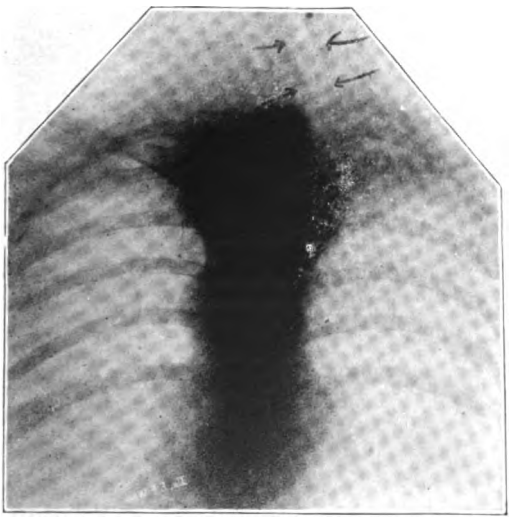

Fig. 2.—Course of deviated trachea (indicated by arrows) and intrathoracic shadow.

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Fig. 3.—Course of deviated trachea (indicated by arrows) and intrathoracic shadow. Outline of trachea exaggerated by mark.

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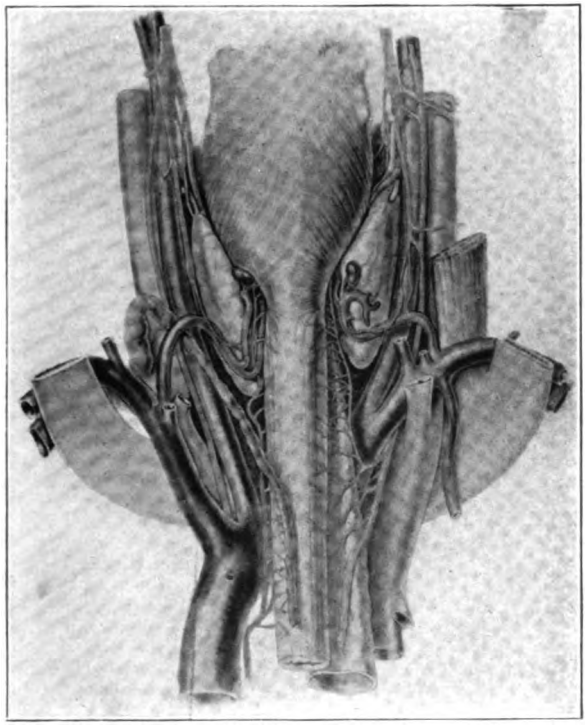

Fig. 6.—Semidiagrammatic painting of a posterior dissection of the neck, made at the thyroid level, showing the length and course of the inferior thyroid artery which permits it to descend into the thorax with the tumor.

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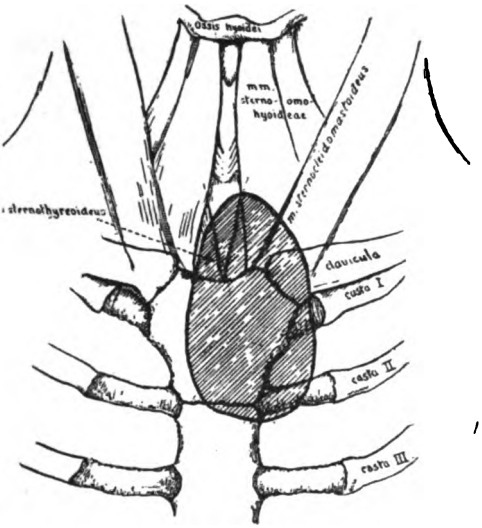

Fig. 4.—Diagrammatic location of intrathoracic mass in relation to the sternum, ribs and anterior neck muscles.

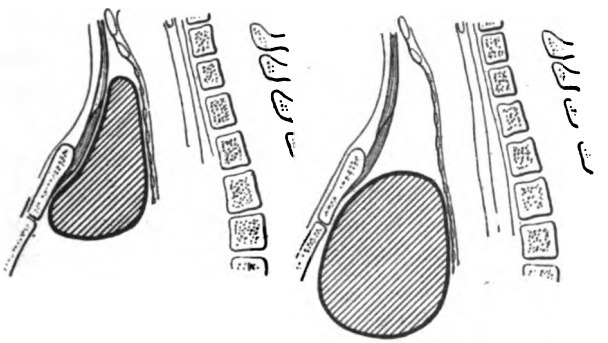

Fig. 5.—Intrathoracic mass shown incompletely and completely, illustrating how, with increased diameter, the upper pole of the mass is drawn into the thorax.

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these growths are possessed of well-marked capsules, one may often clearly trace the shadow of the capsule outlines, a blurring of which is said to create a suspicion of malignancy. Clinically, this is to me a proved fact, as tumors of the thyroid whose lines of cleavage have been lost by fusion of their capsules with surrounding structure have in virtually all instances proved malignant in character.

A late involvement of the recurrent laryngeal nerves, as evidenced by the late appearance of a husky voice, when the tumor has been present for a long time, is also a factor suggesting malignancy.

Intratracheal examination by a trained laryngologist is of great value in the diagnosis of these conditions, as by this means deviation, narrowing or denting of the trachea from pressure may be demonstrated. Not only in the concealed, but also in the incompletely intrathoracic type, this measure has been helpful in demonstrating pressure.

Percussion dulness has been present in all of the completely intrathoracic goiters.

In two of my cases, the upper part of the tumor was just barely palpable below the sternal notch, and this condition is, of course, conclusive evidence of the existence of an intrathoracic mass.

It is assumed that surgery is accepted as the only curative procedure available in this condition, and my remarks in this connection will therefore be limited only to such points as have arisen in my own personal operative experience in dealing with thyroids of this variety.

Perhaps the most essential single feature in the operative procedure is that the intrathoracic mass be delivered as a whole. Piecemeal delivery is to be avoided because of the almost uncontrollable deep bleeding which occurs if the tumor is broken up while still located within the chest. These intrathoracic growths are very vascular within their capsule; but if

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delivered intact they readily permit of vascular control by ligation of their more or less pedunculated blood supply. Piecemeal removal is also to be avoided because of the possibility of leaving adenomatous masses behind, from which recurrent growths may develop.

Since these deeply seated adenomas and cysts no doubt act as foreign bodies within the chest, they become surrounded by a layer of condensed connective tissue, which is of great value. In the first place, it is most essential to remain within this tissue layer while freeing the tumors, as it forms a barrier against the extension of the infection which accompanies post-operative drainage of the resulting cavity. Furthermore, it establishes distinct lines of cleavage, within which one must remain in order to prevent injury to the recurrent laryngeals and the thoracic duct. Finally, penetration of this layer of connective tissue opens up the possibility of venous oozing within the thorax, resulting hematoma, and possible mediastinitis.

The dissection of these completely intrathoracic masses must be by gently sweeping the fingers around the tumor within the lines of cleavage spoken of above. Attempts should not be made to drag the mass out from above, but rather it should be pried out by pressure from below, when possible.

With increasing experience with these deep-lying thyroids, one becomes impressed with the amount of force which it is possible to apply in prying these masses out of the chest.

If all other measures fail, and delivery is impossible, because the diameter of the tumor is greater than that of the upper thoracic aperture, recourse may then be had to splitting the sternum—a measure which was necessary in one of those cases—by which wedges may be inserted, and the thoracic aperture so widened that delivery is possible. It is a surprising fact that if dis-

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section is gentle and within the lines of cleavage, enormous masses may be delivered with virtually no bleeding, since their blood supply enters from above downward, through the inferior thyroid artery and vein, which become elongated and stretched with the descent of the tumor mass, resulting after delivery in a pedunculated tumor; the tumor representing the portion which before delivery lay in the thorax, and the pedicle representing the elongated thyroid vessels.

The question of anesthesia in these cases is a trying one, since operation is often performed under conditions of complete or partial respiratory obstruction. Of the five completely intrathoracic goiters in my experience, one was operated on as an emergency, with no anesthetic; one with a local anesthetic, because of almost complete obstruction; one with intratracheal ether, and two with gas-oxygen. In all of the incompletely intrathoracic cases, operation has been performed with gas-oxygen. Of the five patients, four have made completely satisfactory recoveries. The fifth died on the eleventh day of bilateral pneumonia.

638 Beacon Street.

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ADVANTAGES OF LOCAL ANESTHESIA IN THYROID OPERATIONS

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The thyroid is one of the oldest and most generally recognized fields of application of regional anesthesia. The risks of general anesthesia in such operations are serious and numerous. Madelung and Socin, M. L. Harris, James Berry and many others have drawn attention to the advantages of local anesthesia in thyroid surgery. Among the most important dangers of general anesthesia in goiter operations are: (1) postoperative pneumonia; (2) overtaxing of the heart; (3) overtaxing of the kidneys; (4) increased danger through failure to block the sensory nerve paths, resulting in the needless consumption of nervous energy as explained by Crile; (5) injury of the recurrent laryngeal nerve, and (6) asphyxia of any degree.

Advantages in respect of operative technic ascribable to local anesthesia are:

1. More perfect hemostasis may be obtained through the use of suprarenal extract in nontoxic cases.

2. Dissection of the skin flap may be performed more easily and more quickly, owing to thickening of the panniculus adiposus from imbibition of the solution.

3. There is greater facility of delivery of the gland, owing to the elevation of the lobes on the water-bed and thickening of the capsule.

4. By conversation with the patient, the operator has a constant check on such exhaustion producing factors as pressure of instruments on the vital structures of

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the neck which cause discomfort, if not direct embarrassment of respiration and circulation with asphyxia.

5. The patient can inform the operator at all times whether the head and neck lie comfortably and therefore correctly and safely.

6. Local anesthesia enforces gentle manipulation of the tissues, minimizing pressure on the gland with its danger of overactivation of the heart, as proved by Cannon.

7. Postoperative nausea, vomiting and strangling, with the attendant risk of bleeding, are practically eliminated.

8. The patient can take liquids by the mouth immediately after operation, eliminating proctoclysis, which is annoying to excitable toxic patients.

In a relatively small percentage of goiter operations, general anesthesia may present these advantages over regional anesthesia.

1. There is complete relaxation and unconsciousness.

2. Operation under general anesthesia demands the use of less gentleness and patience on the part of the operator than does regional anesthesia.

3. The operation may be performed more quickly under general anesthesia.

These are doubtful advantages. The excitation incident to the induction of inhalation anesthesia is often greater than that which attends operating under local anesthesia. Here the personality of the surgeon is of great importance. One extensively experienced in the use of regional anesthesia will appreciate and utilize the hypnotic influence of the kindly caressing voice, the tranquil manner, and the attitude of frankness and decision which win the confidence of a timid patient. The employment of regional anesthesia develops these qualities in an operator. This, of course, is in the line of the anoci-association plan, with which the name of Crile is so honorably connected.

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The patient need know very little of what is going on, if a Kocher screen is used or the simple expedient employed of placing a wet napkin of gauze over the eyes. Then, too, the preparation of the patient for the induction of local anesthesia is important in this connection. "The terror of the operating room, and the bad impression which the patient receives owing to the observation of everything connected with an operation are removed or at least considerably diminished if a mild narcotic be administered an hour before the operation is begun. Thus the patient's cerebration is sufficiently blunted to external influences as to prevent further excitement."

Concerning the question of the amount of patience and forbearance which regional anesthesia requires of the surgeon, is it important that the tax on the surgeon is less with general anesthesia? If this is true, is it not fair to say that goiter surgery should be left to surgeons of patience and forbearance as well as technical skill? However great the virtuososhiip of a surgeon in brilliant technical performances, he must lay great stress on the qualities of patience and cool judgment in goiter work.

A great and worthy leader of American surgery said recently that he had no time to perform suprapubic prostatectomy under local anesthesia. Should not the poor "prostatiker" with crippled heart and kidneys be turned over to one of reasonable skill who has enough time to provide the safeguard given by regional anesthesia?

Injury of the recurrent laryngeal nerve should rarely occur in local anesthesia. The surgeon, talking with his patient, can know at once when this nerve is compressed or otherwise traumatized. An interesting experiment under local anesthesia consists in producing hoarseness by compressing the recurrent laryngeal nerve and relieving it at once on releasing the pressure. Traction on the recurrent laryngeal elicits hoarseness and gives timely warning.

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Likewise in goiter surgery, the extra burden imposed on the lung, heart and kidneys by general anesthesia must be viewed with a due sense of its seriousness. Suffice it here to quote Sistrunk, who says that in toxic cases, "with each crisis the damage to vital organs, especially the heart, liver and kidneys, increases until the patient finally suffers more from the symptoms produced by these degenerative changes than from the disease itself." Surgeons who have employed local anesthesia extensively are, I think, as a rule convinced that certain shock producing assaults on the cord or brain may be inhibited to a large degree by its use. This is especially true if the patient is protected from frightful and irritating influences before and during the operation, and if the pain centers are benumbed with morphin.

After regional anesthesia, one does not observe the depression that follows general anesthesia. Briefly, it seems fair to say now that accumulated evidence has established the value of regional anesthesia in the prevention of shock, which is of more avail than its treatment. One need hardly reiterate that, in compliance with the theory of anoci-association, the prevention of pain after operation should receive interested attention.

If the operating is done under regional anesthesia, the surgeon will be reminded that lying in one position on a hard table means discomfort and pain. He will, perhaps, be reminded by the patient, if it does not occur to him, that a pillow in the hollow of the back and a soft comfortable pillow under the head and neck have the effect of reducing the traumatism incident to the operation. He will be taught respect for the nervous system of the patient, and will eventually make regular application of Crile's admonition that general anesthesia does not cut off the painful afferent impulses, but only inhibits their physical interpretation.

It is quite well known that the addition of suprarenal extract to the procain solution in nontoxic cases

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not only lengthens the period of anesthesia produced by procain, but also makes possible a much more complete control of hemorrhage. Fewer artery clamps are required, and this is of importance since the pressure of clamps on the neck, by their weight and traction, may be the cause of the only discomfort felt during local anesthesia.

In this connection it may not be amiss to recall the lessons of Kocher relating to provisional ligation in goiter operations. Artery clamps should not be left on the neck during the operation without good reason. No time is lost if the vessels are tied as soon as they are grasped by the artery clamps. They must be tied eventually, so why permit the wound to be cluttered with the clamps during the operation? The clamps which provide for bloodless division of the ribbon muscles can be removed after interlocking ligatures to the number of four or five on each side are applied under the clamp jaws. If the ends of these ligatures are left long, they may be employed as retractors during the operation, and used to unite the cut edges of the muscles on completion of the operation.

Ochsner admonishes that surgeons who are inclined to be violent in their manipulations should perform thyroidectomies under local anesthesia, with its enforced gentleness, since there is no doubt as to the likelihood of increased postoperative perversion of thyroid function if the tissues are severely traumatized.

The loss of blood seems to have the same effect. It is consequently wise always to clamp each vessel between two hemostatic forceps, cut between these and ligate. In this manner the entire operation may be performed with the loss of almost no blood, and therefore with greater facility. The tissues at the close of the operation will not be saturated with blood, the absorption of which, according to Kocher, increases the likelihood of hyperthyroidism.

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It should not be embarrassing to the operator if the patient converses with him, informing him, perhaps, during the course of the thyroidectomy that traction on a lobe is producing dyspnea, or that the pressure of a hand or of the instruments is causing discomfort. It is one of the valuable advantages of local anesthesia that the patient participates in the matter of protecting himself against unnecessary trauma.

Local anesthesia makes its appeal to surgeons who are willing to consider all of these apparently slight factors of precision and gentleness, to proceed with the caution of a serpent and the patience of Job. It is not a proper field of activity for those who still lay stress on the now discredited surgical showmanship.

Very important is the position of the patient on the operating table. "Let the patient be the judge to tell us whether the head lies correctly. It is not necessary to be guided by the stridor; the patient can say whether the neck is pressed upon or too greatly angulated." [1]

For what good reasons are the head, neck and trunk elevated in thyroid operations? Lowering the head augments the blood supply to the brain and also to the lungs and heart. A position of slight elevation of the trunk, with the neck curving gently backward, is perhaps one of greatest comfort to the patient, and of value for the vital reason that in this position the heart and lungs are less liable to overtaxation. Thus it is of importance that the patient can indicate to the surgeon that he or she is made panicky by an unfavorable position.

If a 1 per cent. solution of procain-epinephrin is injected copiously into the subcutaneous tissues and muscles, there will of course result a marked imbibition and thickening of the subcutaneous panniculus. After becoming accustomed to this, the surgeon will not be disturbed in any way by this resulting imbibi-

1. Schwyzer, Gustav: Diagnosis and Surgical Treatment of Intrathoracic Goiter, J. A. M. A. 74: 597 (Feb. 28) 1920.

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tion; on the contrary, it renders the freeing of the skin flap more easy and more expeditious. Likewise, deep injections at the upper and lower pole not only establish perineural or infiltration anesthesia in the painful areas along the sides of the larynx and trachea, but they greatly thicken the loose weblike fascia external to the capsula propria, which thickening really facilitates freeing and delivery of the lobes.

Postoperative observation of the enormous material of the Mayo Clinic indicates that the degree of improvement that follows thyroidectomy depends to a considerable degree on the extent of damage to the vital organs at the time of operation. If the damage to organs has been extensive, it is impossible to restore the patient to normal health. Here again we are reminded of the great importance of protecting the heart, lungs and kidneys against overtaxation. As a factor assisting in the restoration of the normal metabolic balance following the operation, it is here submitted that the use of local anesthesia offsets to some degree the effects of increased metabolism by bringing up the rate of food intake in the first few days following the thyroidectomy. The patient can take liquids or even house diets, beginning at once after the operation. In dehydrated patients, water or other fluids taken by the mouth render unnecessary the employment of proctoclysis which, in toxic thyroid cases, is as a rule more or less exciting.

If the patient is not permitted to take too much water by the mouth during the operation, there is little likelihood of vomiting either during or after the thyroid operation, and this is of practical interest as postoperative bleeding is as a rule due to postoperative vomiting and strangling.

Thus it is seen that the elimination of vomiting and the administration of food by the mouth immediately after operation have a bearing on the important question of metabolism. In conclusion, it may be said that,

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whereas one perhaps should not take the supercilious position that those who do not succeed with regional anesthesia in thyroid surgery fail because of lack of skill or understanding, it may nevertheless be fair to say that considerable experience must precede efficiency in employment of regional anesthesia, that the use of suggestion or hypnosis secured by an appropriate personality on the part of the surgeon and proper environmental influences is desirable, and that much caution and patience on the part of the operator are indispensable.

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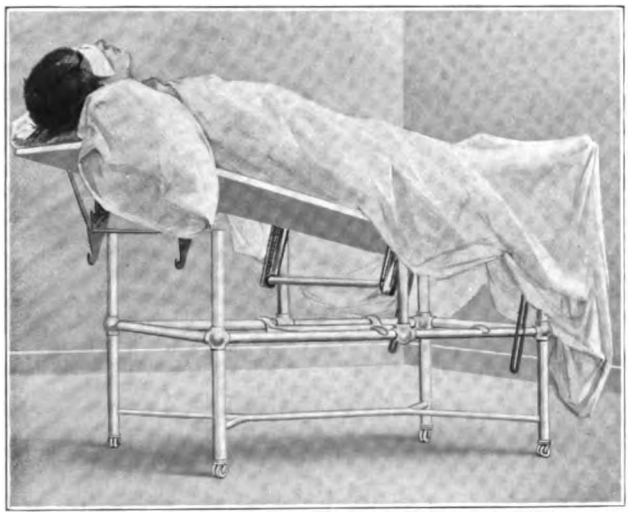

Fig. 1.—Safe and convenient inclination of operating table.

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Fig. 2.—Simple method for making first introduction of small hypodermic needle almost painless, blunting sensation by pressure.

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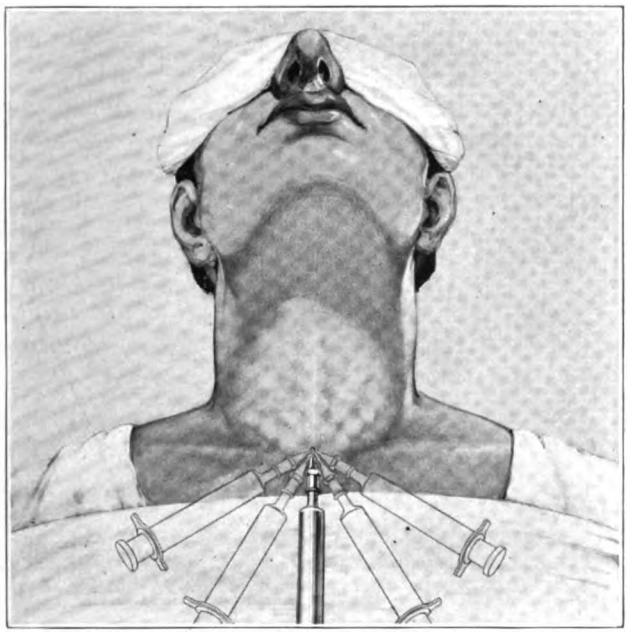

Fig. 3.—Infiltrating all superficial structures through one puncture.

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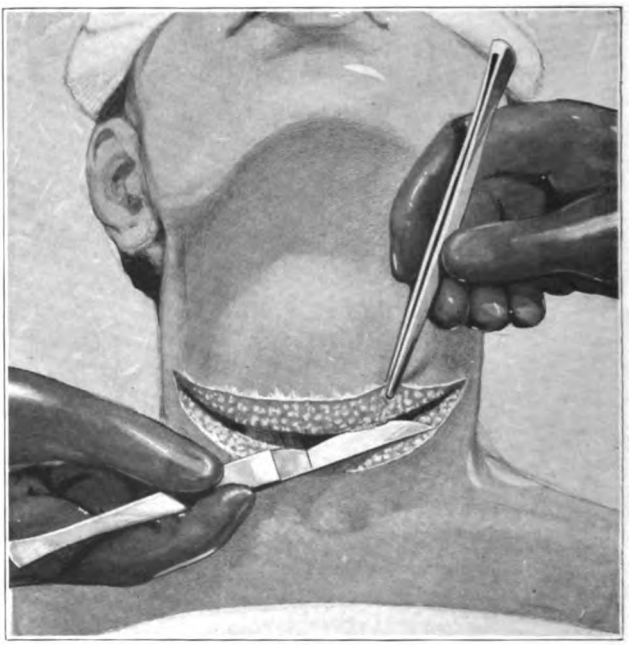

Fig. 4.—Imbibition of panniculus adiposus facilitates dissection of flap.

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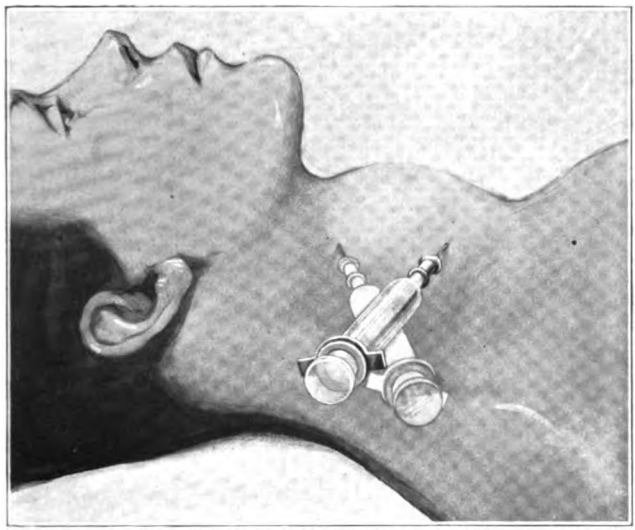

Fig. 5.—Perineural anesthesia of poles.

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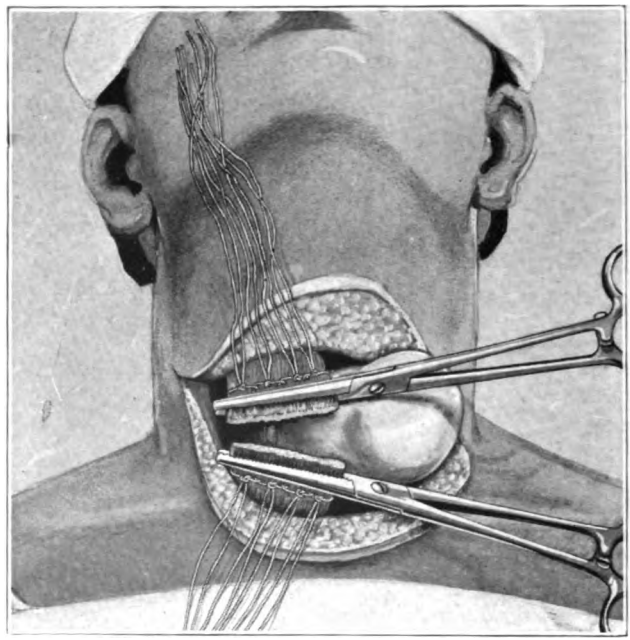

Fig. 6.—Hemostatic sutures in ribbon muscles under forceps jaws make possible the removal of the forceps, freeing the field of all clamps.

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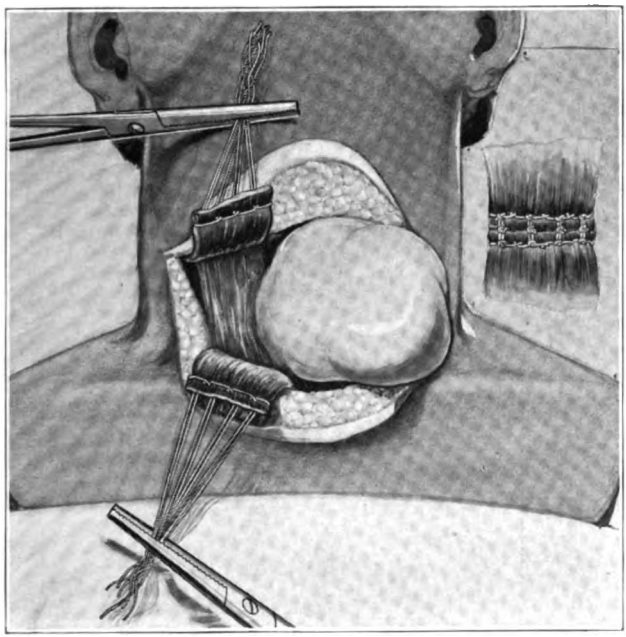

Fig. 7.—Hemostatic sutures in ribbon muscles used as retractors.

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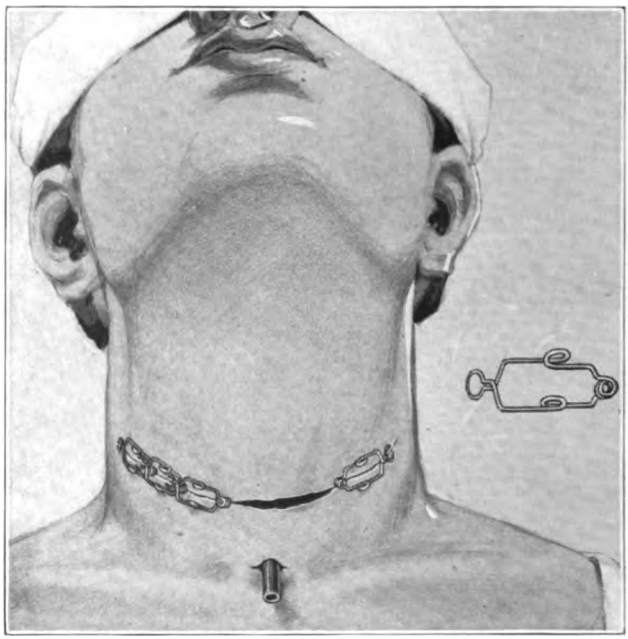

Fig. 8.—Herf clips close wounds quickly and precisely.

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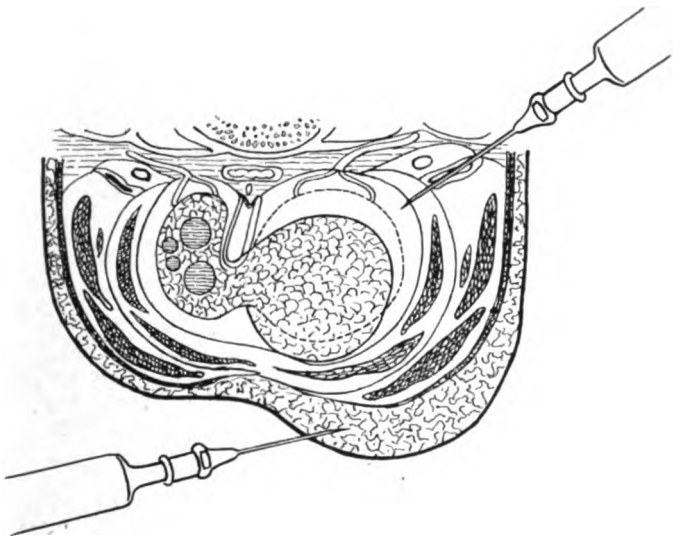

Fig. 9.—Diagram showing thickened panniculus and water bed under lobe caused by imbibition, such imbibition facilitating the turning back of the skin flap and delivery of the gland.

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AN EMERGENCY TECHNIC FOR THYROIDECTOMY

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ST. LOUIS

The admirable Halsted technic, based on anatomic grounds, or some modification of it has up to the present been employed whenever a thyroidectomy has seemed indicated. It has fulfilled all requirements when the patient has been carefully chosen, with an assured margin of safety; still, a number of operative experiences during the last year have shown me that the indications for thyroidectomy may be very considerably broadened by the employment of a technic which is based on pathologic principles and is calculated to make the minimum demand on the patient's strength. To this end, one waives every consideration of a cosmetic nature (although it may be stated in passing that the visual end-result is not so bad as to disappoint greatly the patient, especially if he is a man who wears a collar of ordinary height, or a woman whose matrimonial question has been settled), the sole aim here being to destroy the greatest amount of thyroid tissue possible, which could not be accomplished without risk to life if done in the usual manner.

This may, then, for want of a better expression, be termed an emergency technic: 1. It contemplates the most direct, rapid and bloodless approach to the tumor. 2. It prevents the tissues being contaminated by toxic thyroid juices. 3. It saves the time ordinarily spent in ligating vessels and in closing the wound. 4. It eliminates the accidents which not infrequently cause loss of blood while ligating the

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numerous vessels divided. It naturally follows that shock is rendered unlikely, because, as will be seen, the operation is short, the efferent nerves are blocked, and very little retraction is necessary. Likewise, postoperative hyperthyroidism is not to be expected because absorption cannot take place, the wound being left wide open (absorption, of course, is only a partial explanation of postoperative hyperthyroidism). This phase of the subject, however, cannot lightly be dismissed by one who has seen postoperative temperature invariably drop when fluid was found secondarily in cases in which no change in the central nervous system had become manifest.

In the past, the great danger of thyroidectomy for toxic patients has consisted in our doing too much and thus bringing about a fatal postoperative toxic condition. In consequence, we have gradually been driven to primary ligation for most of the serious cases. In these cases, then, it may not be out of order to attempt primarily a form of thyroidectomy, the gravity of which has been reduced to something like that of ligation. Speaking in general, in the past we have divided our patients into three classes: (1) the safe risks, (2) those who were rejected, and (3) the doubtful class which contains most of our unpleasant postoperative surprises. Nothing need be said here about the first group, those that are definitely fit for any form of operation, or for the second, on whom no one would do more than a ligation, if even that. But this emergency technic is intended for the doubtful patients who seem too good for ligation, but in whom no positive guaranty of safety can be given after a classical thyroidectomy has been done. No less an authority than C. H. Mayo says that ligation is of value only in the exophthalmic hyperplasia type with demonstrable vascular disease; hence the toxic adenomas indicate a thyroidectomy only, if operation at all. Many of these patients are so ill that the classical Halsted operation is highly dangerous to them.

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The preparation for operation does not vary materially from that generally used. We rest these patients, feed them, try to improve the failing circulatory apparatus, and ward off an impending acidosis by the administration of morphin and fluids. No operation of any kind is justified in a person with persistent vomiting.

As soon as the patient has reached the maximum of improvement and becomes sufficiently well acquainted with the surgeon to exhibit any degree of confidence in him, she is taken to the operating room, in full possession of her faculties, without any preliminary morphin for fear of vomiting on the table, the head of the table is slightly elevated, and the face is turned away from the operator. The site of the intended incision is now marked (Fig. 1) just behind the anterior border of the sternomastoid, care being taken not to run down within 1 cm. of the clavicle (Fig. 2), else an ugly scar will result.

A diamond-shaped area is infiltrated about the growth through two needle punctures (Fig. 3), one at each end of the mark just mentioned. It suffices to infiltrate the subcutaneous fat and the muscle planes with 0.5 per cent. procain. As such a patient must under no circumstances be kept lying long on the table, it is well not to wait for a nerve block, but to infiltrate the skin where marked and proceed with the operation just as quickly as possible after she is placed in position.

This form of incision has a number of advantages. It allows one to approach the tumor by the most direct route; it encounters vastly fewer vessels than does the "collar incision;" it avoids the extensive separation of tissue planes as contemplated in making the Halsted flaps; it is in a line with the axes of the important deep structures; it obviates retraction to a very considerable extent, and it insures that the resulting ridge-like scar will lie on a preformed prominent ridge, namely, the sternomastoid muscle.

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As soon as the skin incision has been made, sutures (Fig. 4) are introduced to be tied later, and then held out of the way by an automatic spreader (Fig. 5) which engages in the angles of the wound.

The platysma incision corresponds with that in the skin, this unimportant muscle being the only one whose fibers are divided in any but a line parallel to them. After gentle retraction (Fig. 6) of the lower sternomastoid outward, and of the opposite upper wound lip inward, the ribbon muscles are split longitudinally (Fig. 7) over the most prominent portion of the growth below (Fig. 8). It will usually be found that the upper pole and superior thyroid vessels lie directly under the upper angle formed in the divided ribbon muscles, thus greatly facilitating the further progress of the operation. It will be noticed just here that the gentlest possible retraction gives all the room for approach that is needed, quite contrary to the experience that all of us have had when operating through a midline ribbon muscle incision.

The exposed lobe is now caught with two or three light intestinal clamps and gently lifted. At this point the whole defect is flooded with alcohol (Fig. 9) to seal up all tissue spaces against absorption of toxic material to be liberated in amputating a moment later. As a further guard against this accident, we often pack the furrow around the gland with a roll of dental cotton, provided there is room enough, which is by no means always the case.

The upper pole is now divided (Fig. 10) and the lobe gently drawn toward the angle of the jaw, while capsule and goiter substance are divided after clamping from above downward (Fig. 11). In this way it becomes surprisingly easy to slip out the lobe gently with the minimum of work about the lower pole, and without roughly luxating the gland with the finger, provided there is no outspoken parathyroiditis. By working in this way, the procedure is rendered practically bloodless and the patient disturbed not at all.

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In some instances the stump has been cut off with the cautery, thus destroying thyroid juice as liberated, and at the same time sealing over denuded surfaces. It must be admitted, however, that this may be an unnecessary refinement.

None of the clamps on thyroid substance are ligated in order to reduce tissue necrosis to the minimum. No attempt is made to whip over the cut thyroid surface, fearing retention of toxic products and consequent symptoms. In other words, ***all of the clamps are left on the stump*** (Fig. 12), although in most instances we have ligated the few which were required to control bleeding from the other subcutaneous structures. In one instance a total of fourteen clamps was left in place; in another, twenty-six; in another, thirty-four, and in one other still a larger number of which no count was made. The instruments we employ are the lightest that are adequate, namely, the clamp designed by Dr. Halsted, and used commonly in his clinic at the Johns Hopkins Hospital. The instruments are bunched together by a mass of dressing wrapped about them in such a way as to bring pressure to bear on the skin of the neck, and on their handles (Fig. 13), thus tending to lift their weight upward instead of allowing them to rest on the floor of the defect. The whole bundle is now covered with cotton, and a bandage applied around the neck and under the arms.

It goes without saying that a wound held open in this manner cannot possibly retain the fluids forming in it; hence the most complete drainage is secured. The patients who have been operated on in this way have complained of sore throat in just about the measure we see it in other forms of lobe resection. I will say that they almost universally have difficulty in swallowing until the moment when the clamps are released, then they are suddenly freed from this minor discomfort. It will be recollected, in passing, that many a person whose neck has been sewed up in the ordinary way swallows with difficulty for a day or two.

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Postoperative bleeding and pain have resulted from the removal of gauze, which in some of the earlier instances was packed in the spaces left between the clamps. It is therefore deemed inadvisable to use any packing at all when the clamps are left in place.

The after-treatment consists in giving one-half grain of morphin (the tolerance of these patients is always high on account of high metabolic rate) on leaving the table, so that severe after-pain may be avoided. It is customary to repeat this dose as often as the patient's respiration goes over 20, else restlessness may have the effect of wearing out a damaged heart. We have used Crile's ice pack, applied on a rubber sheet over a thin cotton blanket, laid on the patient's night dress. This invariably reduces a high temperature at about the rate of 2 degrees an hour, and does much to decrease restlessness. We have for many years been in the habit of turning an electric fan directly on all of these perspiring patients, with very much the same result as one gets from the ice pack, having been under the impression that the metabolic rate increases about 10 per cent. with each degree of fever. When there is vomiting or inability to swallow, water is always pushed in the form of hypodermoclysis.

The original dressing should not be touched until the postoperative storm, if there be one, is over. Strange to say, these patients do not complain of the weight of the clamps; at least they have not complained up to a number of Halsted clamps as high as thirty-four; hence there is no reason to touch them during the first twenty-four hours when, if the patient is quiet, it is our custom to unlock all but those on the superior thyroid and let them fall off in the next few hours by virtue of their own weight. This causes no discomfort, provided it can be done with the utmost gentleness. The wound is usually found full of serum when the clamps are removed. This is expelled by tissue shrinkage, which follows the removal of the instruments, and the defect is practically obliterated

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when the skin stitches are tied at the expiration of the second twenty-four hours. Some little discomfort always attends this act, but it is distinctly less than that caused by the application of skin wound clips; however, no local or other anesthesia has ever been required at this time. One is surprised at the expiration of forty-eight hours to see how little need there is for any form of skin closure. The application of adhesive plaster would answer all requirements were it not for the tendency that the lips of such a skin wound show to roll inward.

It will be noted that the operation is over as soon as the lobe has been amputated, a fortunate circumstance when it is recalled that the resistance of a toxic patient under local anesthesia is about gone when this stage of the thyroidectomy has been reached. This practical observation tends to discount the fact that it is *theoretically* far from ideal to leave a large number of clamps in any surgical wound. One who entertains the idea for the first time might be justified in thinking of shock, postoperative discomfort, possibility of infection and cosmetic deficiency. In practice, the procedure has not worked out thus; on the contrary, the operation has been greatly shortened, perfect drainage has been secured, and there has been none of the hemorrhage that occasionally complicates the tying-off of many clamps. In some instances the undertaking is much better borne than was anticipated in the beginning, and one is justified in going further and ligating in the ordinary manner, then packing the defect with gauze or with soft rubber, which we consider better. However, the gain is very slight, excepting so far as surgical traditions are concerned. The longitudinal slit in the ribbon muscles tends to close spontaneously as soon as their function is exerted. The sternomastoid slips forward to cover the defect in them; the thin platysma defect can be disregarded, while the skin is closed well enough for all practical

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purposes by the tying of the few sutures which were introduced at the operation and left long for that purpose.

Limitations on time and space prevent one's going into details of clinical histories. I can state, however, that the early postoperative period has been rendered so comparatively free from toxic symptoms by this technic as to make one feel justified in resecting one lobe on a considerable percentage of patients who were formerly not thought able to bear the operation as performed in the commonly accepted manner.

410 Metropolitan Building.

ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. MASON, LAHEY, EASTMAN AND BARTLETT

DR. HENRY S. PLUMMER, Rochester, Minn.: Dr. Lahey's general analysis of the goiter situation was in line with my views. A basal rate of plus 15 or 16 can be accepted as meaning that the case is one of hyperthyroidism with adenoma. That does not apply to exophthalmic goiter. The risks of goiter are evident largely in the case of patients who have been hyperthyroid for more than a year. We must learn not to wait until the patient is a bad surgical case before we operate. Sixty-five per cent. of the cases come to us in the first year. A relatively small percentage of the mortality comes from that 65 per cent. Postoperative reaction, the so-called postoperative thyroidism, raises the question whether a patient can stand this sudden discharge of thyrotoxins into his system. We do not even definitely know the crucial point on which this postoperative reaction depends. Until we do know that, we will not know the line of attack which will bring the highest benefit.

DR. EMIL GOETSCH, Brooklyn: Dr. Mason brought out some interesting points with regard to partial reduction of hyperthyroidism. I should like to know why he prefers the repeated use of the cautery instead of ligation. The theory of partial reduction of hyperthyroidism consists largely in the destruction of gland substance or in reduction of its vascularity. After all, secretion of the gland depends on its blood supply. I cannot quite see why it is preferable to redevelop the operations which are more mutilating. I think that repeated cauterizations are less advantageous than single, quick ligations. With regard to the neatness of ligation, I have never been able to convince myself that the cautery is preferable. Dr. Lahey has called attention to the very definite aid which the roentgen ray affords in the diagnosis of

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Fig. 1.—Site of intended incision marked before infiltration is commenced.

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Fig. 2.—Relation of incision to clavicle, external jugular vein, and spinal accessory nerve.

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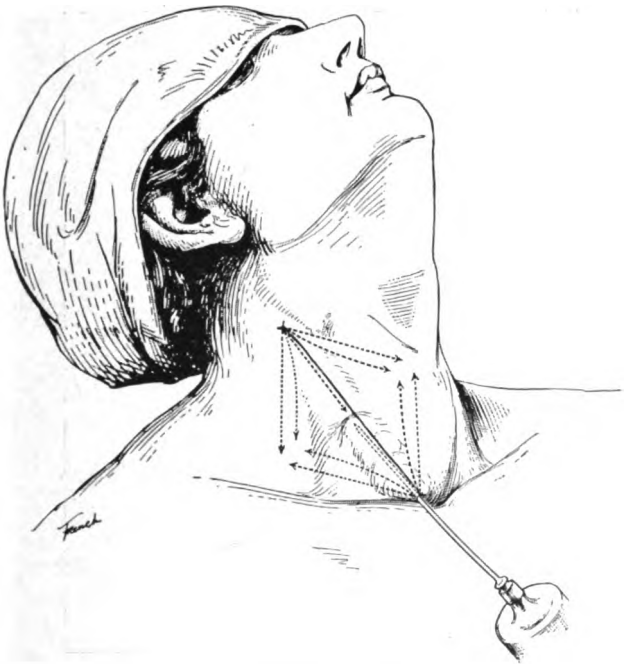

Fig. 3.—Infiltration in two planes about tumor; also the skin in line previously marked.

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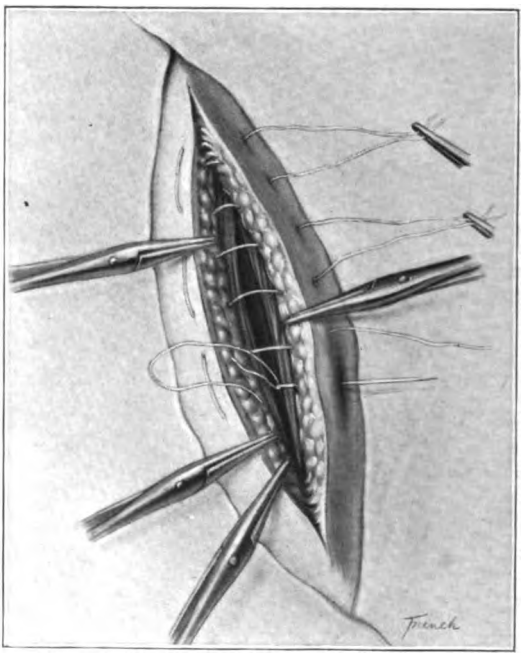

Fig. 4.—Introduction of skin sutures.

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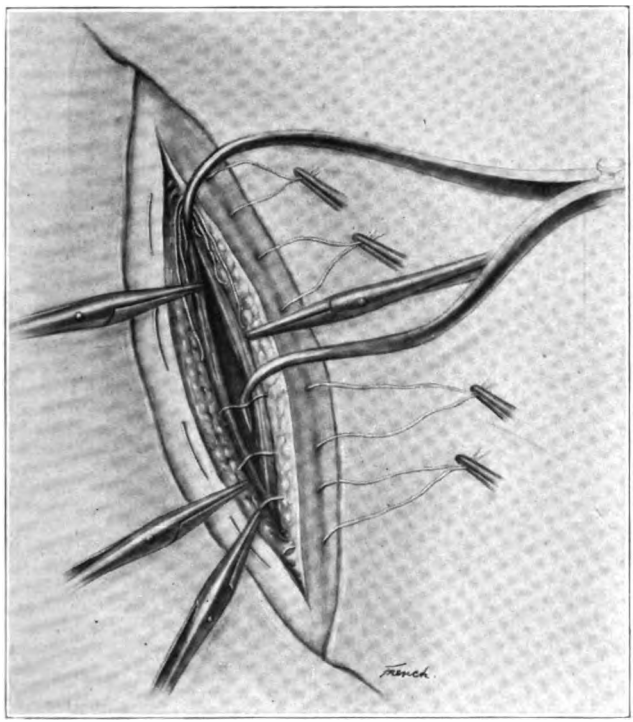

Fig. 5.—Sutures held out of way by automatic spreader.

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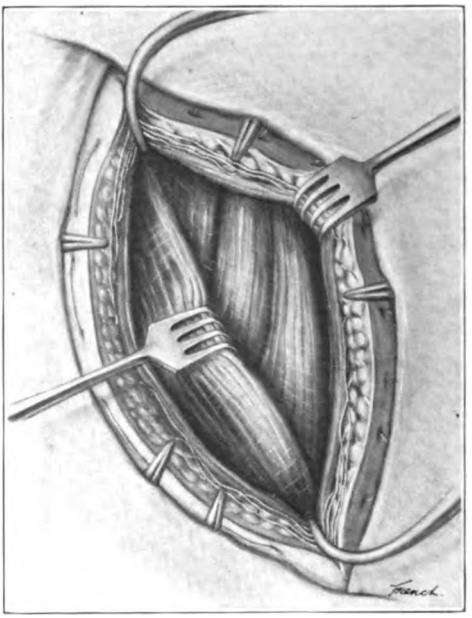

Fig. 6.—Retraction of sternomastoid to expose ribbon muscles.

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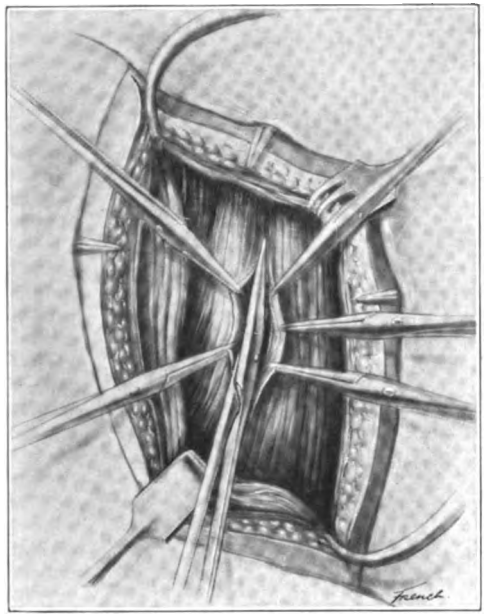

Fig. 7.—Ribbon muscles split longitudionally.

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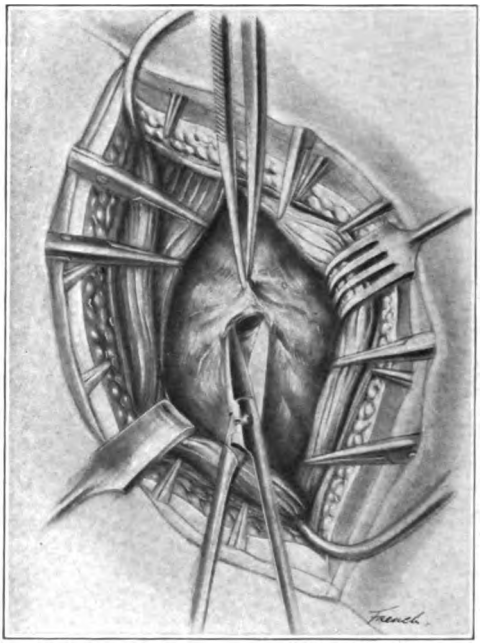

Fig. 8.—Tumor exposed.

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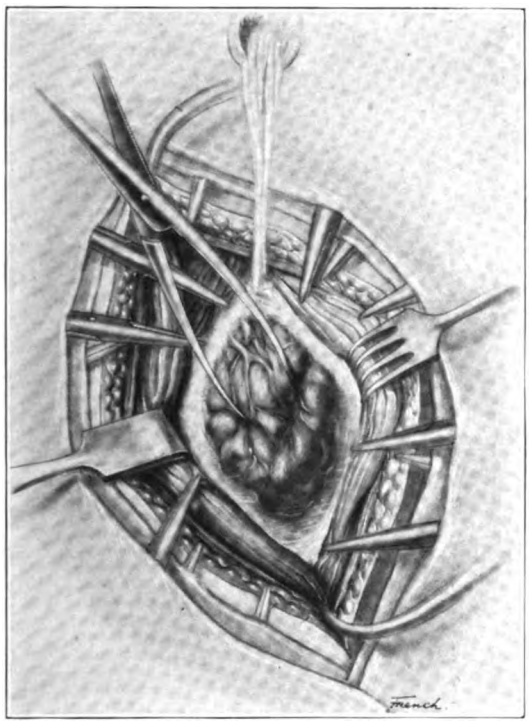

Fig. 9.—Defect flooded with alcohol to seal up tissue spaces.

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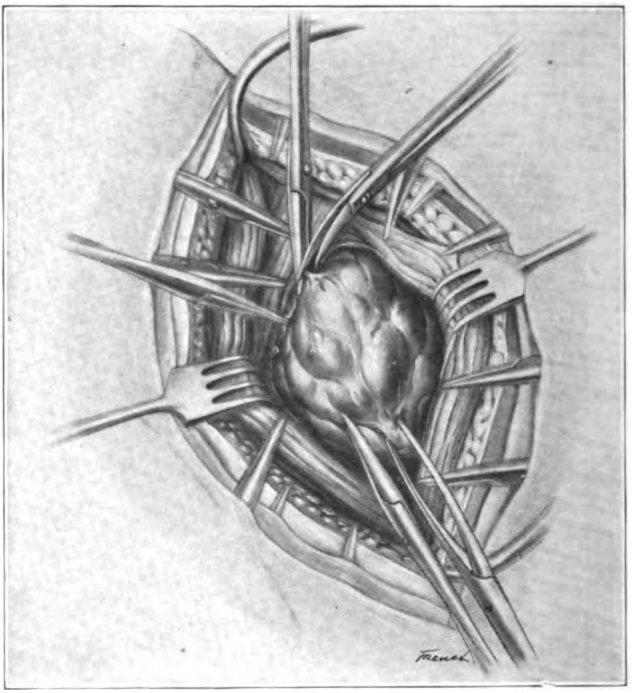

Fig. 10.—Upper pole divided.

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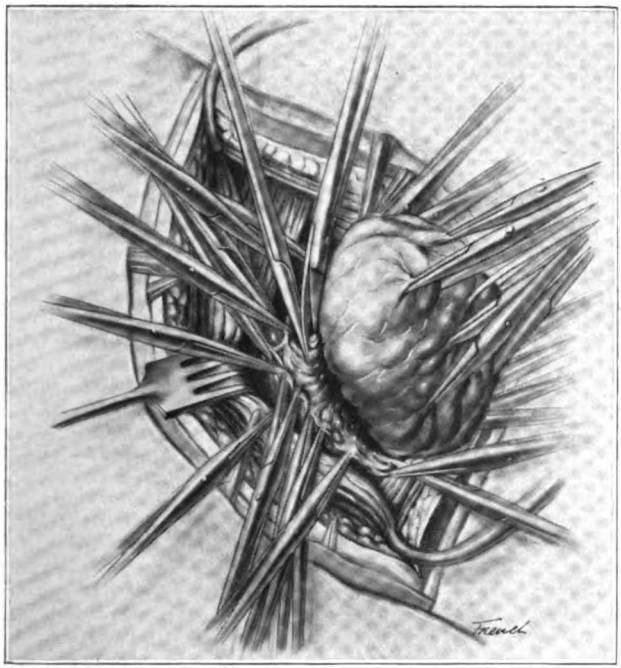

Fig. 11.—Stump divided from above downward.

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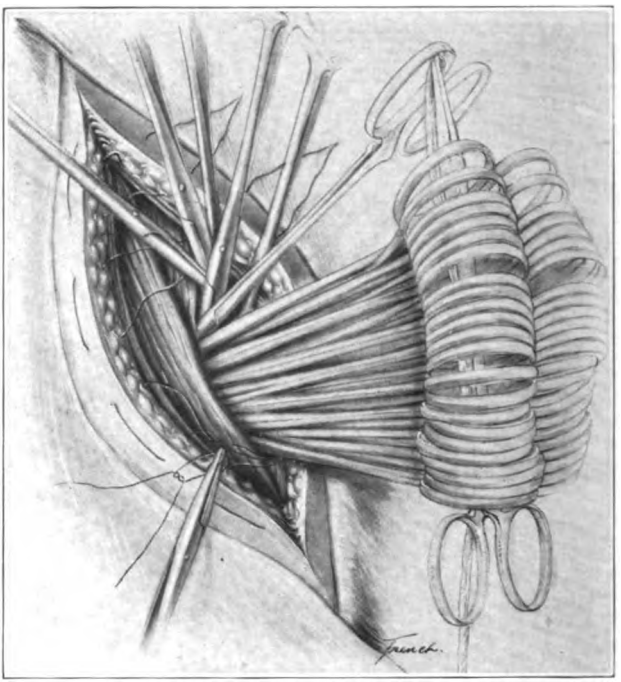

Fig. 12.—Clamps left in place on superior thyroid and stump.

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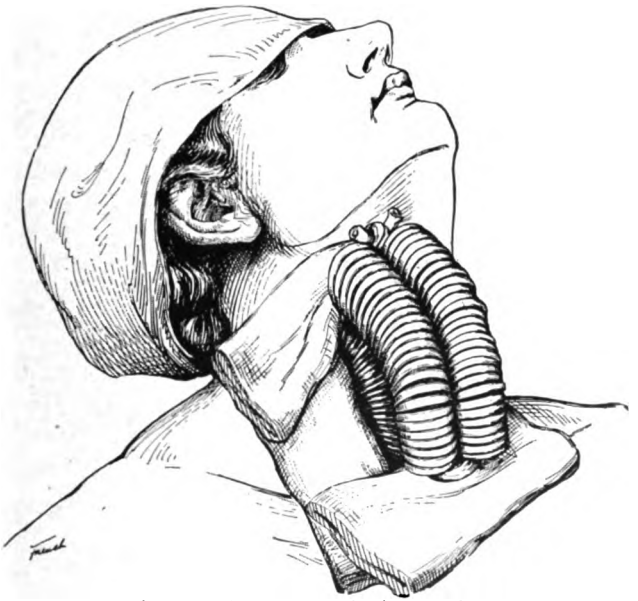

Fig. 13.—Clamps wrapped with dressings.

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adenoma cases. I have made use of the roentgen ray in some cases and have been able to confirm our suspicions that a deep adenoma was present. With regard to the origin and mechanism of these intrathoracic growths which he mentioned, occasionally a growth of this kind seems definitely to have its origin in accessory thyroid tissue. In certain instances there is no connection between these growths and the thyroid. In one instance its structure was the same as a demonstrated accessory thyroid at a higher level in the neck. The new tumor had an independent blood supply. It is well worth remembering this possible origin of these accessory tumors. In one case of acromegaly a large colloid goiter originally was situated in the neck, but with the enlargement of the shoulder girdle, this tumor descended into the mediastinum and was not even palpable above the jugular notch. If the psychic element in thyroid operations is so important, particularly in exophthalmic goiter, as claimed by Crile, I cannot understand why one should resort to local anesthesia in exophthalmic goiter cases in which procedure the psychic element certainly is present to disturb the patient. I have repeatedly noticed a preliminary pulse rate of 140 or 160 fall to 110 or lower under the anesthetic and remain so during the course of the operation. This is evidence of considerable value to show that as far as the stimulating effect on the pulse is concerned the patient is apparently better off under a simple general anesthetic than under a local anesthetic. As far as the pulse may be considered an index of toxicity, there is less of the latter under nitrous oxid-oxygen anesthesia than when a local anesthetic is employed.

Dr. Edward G. Jones, Atlanta, Ga.: If some medical men are inclined to discredit thyroidectomy and to criticize early operators in this field, they ought to keep in mind that these pioneers had to grope their way carefully to discover the proper margin of safety. These early operators were justified in their caution to remove too little rather than too much thyroid tissue; so that if they had to operate on some patients a second time this circumstance is not a reflection on their judgment. I have never seen a patient who suffered from having had too much thyroid tissue removed at operation; though I am well aware that there is a line of danger, and that such a statement ought to be made with circumspection. Patients have not come back for so-called recurrences. It is true that in some patients I have left one side because it seemed bad judgment to tax them with a double resection. These patients ought to have had a second operation, but usually declined it because of the improvement gained from the one sided operation. Dr. Bartlett's procedure is a commendable effort to provide one more way of handling satisfactorily the class of patients for which he recommends it. It is doubtless true, as he says, that this

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operation does some violence to cosmetics, and is a little iconoclastic as to the traditions of surgery; but we must remember that the individual under consideration is not much concerned about a scar in the neck, and takes only an academic interest in the traditions of surgery. Anociation should begin the very first time the patient comes under observation, and be continued throughout the whole care of the patient. Goiter is relatively rare in the South. The incidence in the colored race is undoubtedly smaller than in the white race. A nontoxic goiter does not usually compel an individual to consult a physician, and the negro does not do it. One third of our colored patients had exophthalmic goiter.

Dr. A. J. Ochsner, Chicago: You will find a great deal of satisfaction in following the advice that Dr. Bartlett has given in a certain series of cases similar in character to those which he has described. Most of you will share his doubt about the wisdom of leaving on the clamps. The amount of shock avoided by the few moments of taking off clamps will usually be greatly multiplied by the annoyance of leaving them on. We have compared hundreds of cases operated under local and general anesthesia, and, as a rule, the patient operated on under local anesthesia is less badly off on the day after the operation than the one who has been operated on under general anesthesia. However, we have found that by performing gastric lavage with water at 105 F. immediately after the operation in cases in which general anesthesia was used, these patients are almost in the same condition afterward as those that have had local anesthesia. As a rule, we perform all goiter operations under local anesthesia at the present time, provided there is no reason why we should not do it, that is, if the patient is not excessively afraid of the local anesthesia. With regard to substernal or subclavicular goiters, I wish to refer to a procedure which you may find convenient to employ at some time. In a few of these cases, before I made use of this precaution, the patient gave a sharp cough after the tumor had been delivered and burst the pleura which caused me much worry. Now I immediately place a moist sponge in the space produced when the goiter is lifted out of its substernal or subclavicular location and then go on with the operation. The explanation which Dr. Lahey has given about the goiter being forced down by the strong anterior muscles is an excellent one. In cases in which the goiter was poststernal and post clavicular we have found that usually the anterior muscles are especially heavy, and it has been so in many of these cases in which in the earlier times we considered the goiter too small to give rise to the symptoms which existed. I believe every close observer has confirmed what Dr. Mason said about the late conditions of the heart due to hyperthyroidism. Landstrom brought out this fact fifteen years ago, that degenera-

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tion, once it has occurred in the heart, will not disappear, and the advice Dr. Mason has given is absolutely correct. In order to avoid that degeneration we must operate early.

Dr. Andre Crotti, Columbus, Ohio: I have operated in more than 1,000 cases of goiter of all forms. In the last 500 cases, the death rate was about 2 per cent. The anesthetic used was ether-oxygen. In dealing with intrathoracic goiters, one must have a complete knowledge of the anatomy of the region; one must be sure to locate the right plane of cleavage; otherwise only disasters will be encountered. No attempt ought to be made at delivery of an intrathoracic goiter before the upper pole has been entirely ligated, cut off, and the whole lobe isolated as far down into the thorax as possible. This procedure is very important because in many instances the connection of the intrathoracic with the cervical lobe is a very thin one. It may be the only hold that one may have to pull on the goiter. When the time of delivery is reached, go very gently around the goiter and separate it from the mediastinal organs, especially the blood vessels, and only then shall we attempt the delivery of the goiter itself. Now, either the goiter is small enough to go through the superior opening of the thorax and then the delivery will be very easy, or it is too large and at that critical time of the operation an unpleasant complication occurs, namely choking. So far as anesthesia is concerned in those cases, one must be guided entirely by the condition of the goiter and of the patient. If the goiter is accompanied with bronchitis, catarrh, dyspnea, or marked compression on the trachea, then local anesthesia ought to be used. It is in these cases that choking spells are apt to occur in the early part of general anesthesia and one must be prepared to meet the situation. In the majority of cases, however, ether or nitrous oxid will do well.

Dr. Malcolm L. Harris, Chicago: Operations on the thyroid under nerve blocking is one of the most satisfactory procedures in the field of local anesthesia. The region should be blocked by bilateral blocking of the cervical plexus, which may be done very easily by a single needle puncture on either side of the neck. Under this method of blocking the entire anterolateral region of the neck is completely anesthetized and any operation in this region may be done without pain. Concerning the psychic effect of operations on goiter, even the toxic variety, this is largely in the mind of the operator and not in that of the patient. The patients under complete blocking will have no psychic effect, and if properly handled by the surgeon, the patient will leave the table in infinitely better condition than under any general anesthetic with which I am acquainted. Recovery is easier and shorter and in place of local anesthesia being a step backward it is one of the greatest steps forward introduced in operations on the

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thyroid, as it is in operations on other regions of the body where it is applicable.

Dr. George W. Crile, Cleveland: I have found objections to using local anesthesia alone on account of the important psychic factor; there are objections to using general anesthesia alone, because in serious cases of exophthalmic goiter there is so great an interference with the internal respiration that inhalation anesthetics may cause much injury by added suboxidation. Therefore, in serious cases we take the operation to the patient in bed. Using local anesthesia with analgesia under nitrous oxid does not interfere with the internal respiration of the cells. This plan has succeeded remarkably well. Also, in certain cases we allow the wound to remain open in order to prevent the absorption of toxins from the wound and to promote postoperative comfort. A comfortable patient is more likely to make a good recovery. The important note I gathered from these papers was that the operators have found that it is important to conserve to the utmost degree all the resources of the patient and to add other factors of safety, by good judgment, by a graduated operation, by doing the right thing at the right time, by local anesthesia, by general anesthesia. Thus they have been able to achieve great progress in the surgical treatment of exophthalmic goiter.

Dr. J. Tate Mason, Seattle: We do not repeat cauterization if the patient is a safe risk for ligation. The cauterization is not done twice in the same place. We follow a line which eventually is removed by the thyroidectomy incision. The scars will be lost in the one continuous scar that is made when the thyroid is removed. I felt somewhat uneasy in reporting such a large percentage of cases of reoperation. They were our earlier cases of six or seven years ago.

Dr. Frank H. Lahey, Boston: An important diagnostic point of intrathoracic thyroid is deviation of the trachea to one side. One other point regarding the handling of these intrathoracic masses is the danger of injury to the recurrent laryngeal nerve. There must necessarily be some cases in which injury will occur, since manipulations are naturally digital, and the course of the nerve is often markedly distorted. It is therefore wise to explain this possibility to the friends or family before operation is undertaken, thus eliminating the complications that may arise if the explanation be delayed until the operation is over.

Dr. Joseph R. Eastman, Indianapolis: Dr. Crotti and Dr. Crile struck a very important note. Local anesthesia is of great value and is especially applicable in the bad cases. These are the cases which concern us most. If a man uses local anesthesia habitually and has become accomplished in its use, then he will be the better prepared to deal with the serious cases in which its use is demanded. I am pleased to have the endorsement of local anesthesia by Dr. Harris.

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CONGENITAL HYPERTROPHIC PYLORIC STENOSIS

REVIEW OF ONE HUNDRED AND SEVENTY-FIVE CASES IN WHICH THE FREDET-RAMMSTEDT OPERATION WAS PERFORMED

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NEW YORK

Before taking up the subject matter of this paper, I wish to call attention to an error that has crept into the literature involving the question of priority in the use of extramucous pyloroplasty. The value of this procedure in the operative treatment of hypertrophic pyloric stenosis was first called to our notice at the Babies' Hospital in 1914, and very shortly afterward it was adopted as the routine operation in these cases. Without properly verifying references we attributed the method to Rammstedt, as had been done by other surgeons. The mistake was not realized until some years later, when Dr. Alanson Weeks of San Francisco called my attention to it. After a careful search of the literature, I find that Dr. Weeks is correct, and that Fredet,[1] a French surgeon, deserves credit for the essential feature of the operation, that is, longitudinal incision of the serous and muscular coats of the pylorus, thereby liberating, but not opening, the mucous layer. This surgeon then converted the longitudinal incision into a transverse one by suturing. Two years later, in 1910, Weber[2] of Germany recommended the same procedure, calling it partial pyloroplasty, and stating that after he had performed this operation he found it had been previously employed by Fredet. In

1. Dufour, H., and Fredet, P.: Rev. de chir. 37: 208, 1908.
2. Weber, W.: Berl. klin. Wchnschr. 47: 763, 1910.

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1912, Rammstedt [3] called attention to the advantages of Weber's procedure, but advised omission of the transverse suture and suggested leaving the pyloric wound gaping. As this modification has been adopted by most surgeons using the extramucous or partial pyloroplastic operation, Rammstedt should receive credit for the suggestion, and the operation styled the Fredet-Rammstedt operation.

All patients with hypertrophic pyloric stenosis on whom I have operated, according to the method just mentioned, from 1914 to January, 1920, are included in this report. At the Babies' Hospital, 165 operations were performed; at St. Luke's four, and the remainder in other hospitals. There were thirty deaths in the series, giving a mortality of 17.1 per cent. The results, judged purely from a statistical point of view, are disappointing; and yet a study of the records brings out the fact that the mortality in patients coming to operation in four weeks or less from the date of the onset of symptoms was only 8 per cent. The rule of classing all deaths in the hospital following operation as operative deaths is strictly adhered to, even though several babies died from two to four weeks after operation, and had apparently made a satisfactory recovery. If this rule was generally adopted in recording results, statistics would be of more value. Eighteen babies died in collapse in from three to seventy-two hours. It is only fair to state that all were in extremely poor condition, and that many of them could easily have been classed as hopeless and operation refused; but as we felt that surgical intervention offered the only chance of recovery, they were given the benefit of the doubt.

The average age of this group was nine weeks, with a history of symptoms for more than five weeks. The weight averaged 6 pounds—a loss of more than 2

3. Rammstedt, C.: Med. Klin. 8: 1702, 1912. Zentralbl. f. Chir. 40: 3, 1913.

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pounds each—amounting in several instances to more than one third of the body weight. Postmortem examination was negative in every case. Four deaths occurred in from ten to twenty-six days after operation. In two instances necropsy disclosed acute gastroenteritis; but in the other two, findings were negative and for want of a better diagnosis they were called marasmus. The remaining eight deaths were due to complications, and can be charged, with probably one exception, to bad technic or poor judgment. Five of the eight died of general peritonitis in from eight to ten days. Two of these deaths occurred early in the series in cases in which the operation was modified by passing a bougie through the pylorus by means of a small opening in the anterior wall of the stomach. A third occurred in a case in which the duodenum was accidentally opened, although no evidence of leakage was found at necropsy. In the remaining two, no explanation can be offered for the development of peritonitis other than faulty technic.

In passing, it might be well to call attention to the fact that peritonitis was not suspected in at least two instances, as the symptoms were not classical, and for this reason one should be guarded in giving the cause of death after operation in infants as collapse, inanition, etc., unless proved by necropsy. Hemorrhage was responsible for the death of three of the patients. One died in twenty-six hours as a result of bleeding from the pyloric wound; one, apparently a true hemophiliac, died on the third day of continuous oozing from the pylorus and abdominal wall, and in the third, with a history of symptoms for twelve weeks, death occurred on the third day following delayed hemorrhage from the abdominal wound. While the amount of blood lost was small, no doubt this accident hastened the fatal termination. In only one case was there evidence at necropsy to indicate that the operation was inadequate, so far as relieving the obstruction was concerned.

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The diagnosis of hypertrophic pyloric stenosis is based on the history and physical findings. As vomiting, usually forcible in character, is the first sign that attracts attention to the disease, the onset should be considered as dating from the appearance of this symptom. Loss of weight, more or less rapid according to the severity of the condition, immediately follows. The size and character of the stools vary with the amount of food passed through the pylorus. When the abdomen is inspected, visible peristaltic waves situated in the epigastric region and passing from left to right may be seen in practically every case.

While waves of this character are observed occasionally in conditions other than hypertrophic pyloric stenosis, in only one of our proved cases of this disease was this physical sign lacking, and for that reason we consider it of great diagnostic value. By gentle but deep palpation, the so-called tumor consisting of the hypertrophied circular muscle fibers of the pylorus may be felt to the right and above the umbilicus, or at times high up under the liver or even in the middle line just below the ensiform. This tumor varies in size from the terminal phalanx of the little finger to that of the thumb, and gives an almost cartilaginous sensation to the finger even through the abdominal wall.

Just before the abdomen is palpated, the stomach should be emptied of gas by the passing of a small catheter, and the abdominal muscles relaxed by allowing the baby to suck water from a bottle during the manipulation. If these points are borne in mind, the hard, movable nodule at the pyloric end of the stomach can be felt with little difficulty in nearly every case. Occasionally it may be necessary to give a few whiffs of ether or ethyl chlorid to secure satisfactory relaxation of the muscles.

The question of feeling the tumor in these cases has given rise to no end of discussion. Undoubtedly, there is a certain knack to the procedure; but if the nodule is once felt distinctly, the chances of recognizing it

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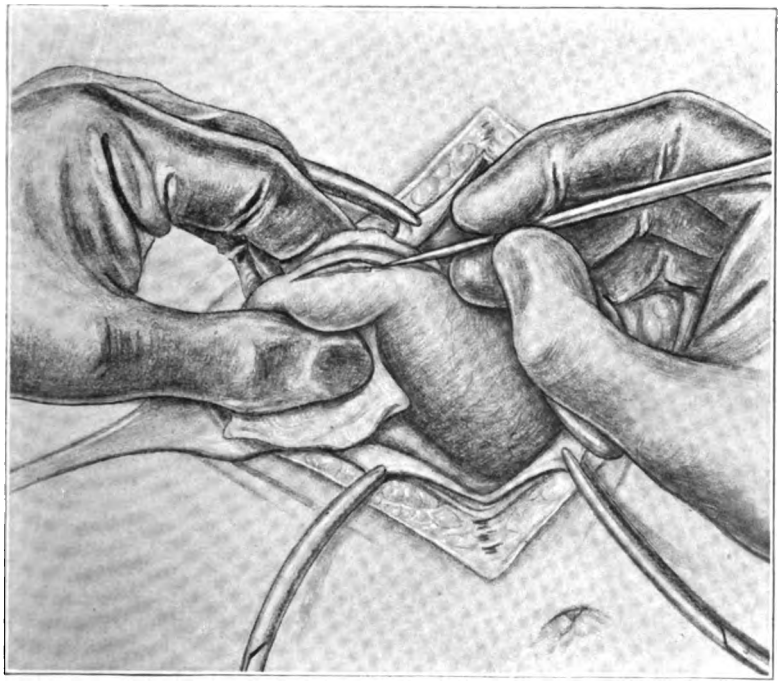

Fig. 1.—Line of incision extending through serous coat and superficial fibers of circular muscle.

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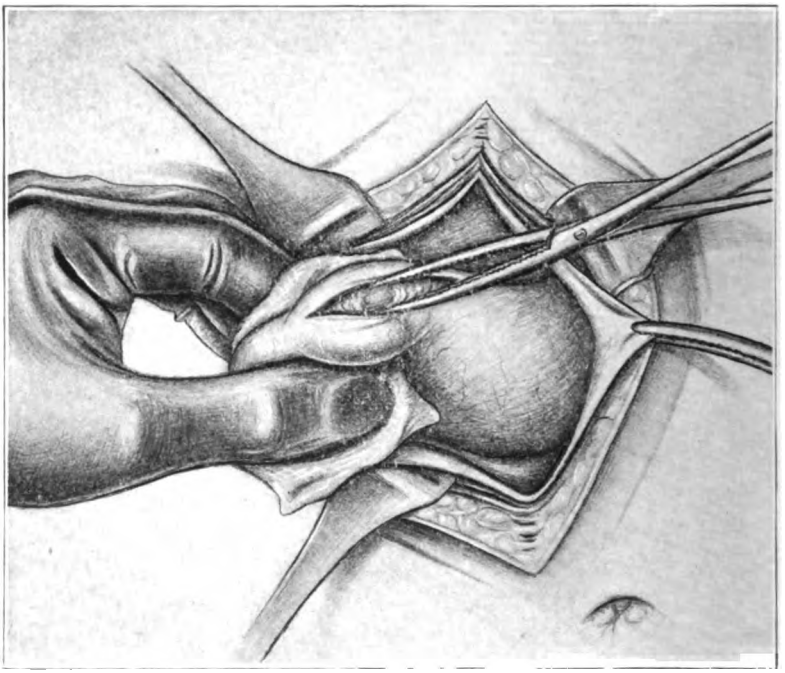

Fig. 2.—Incision spread with artery clamps; mucosa beginning to appear between divided muscle fibers.

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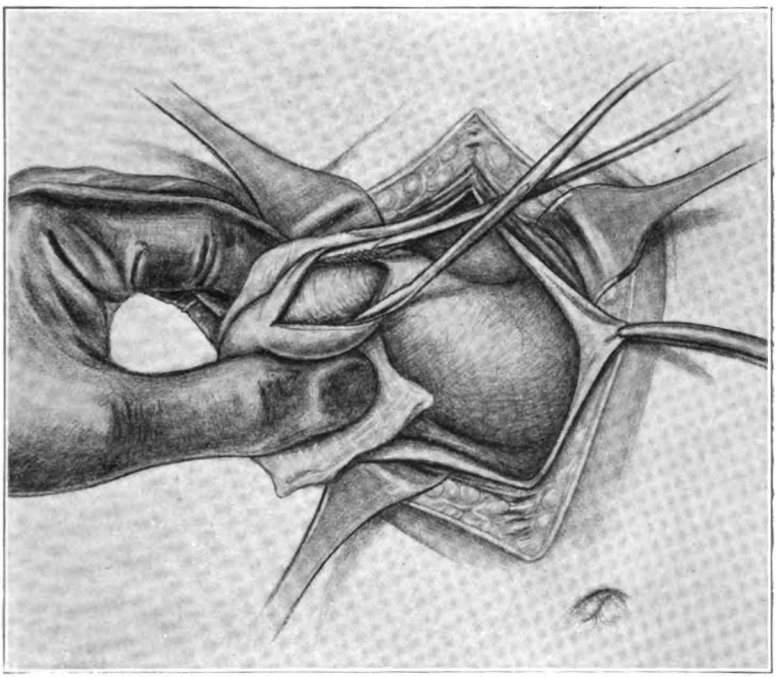

Fig. 3.—Mucosa protruding freely between cut edges of muscle; operation completed.

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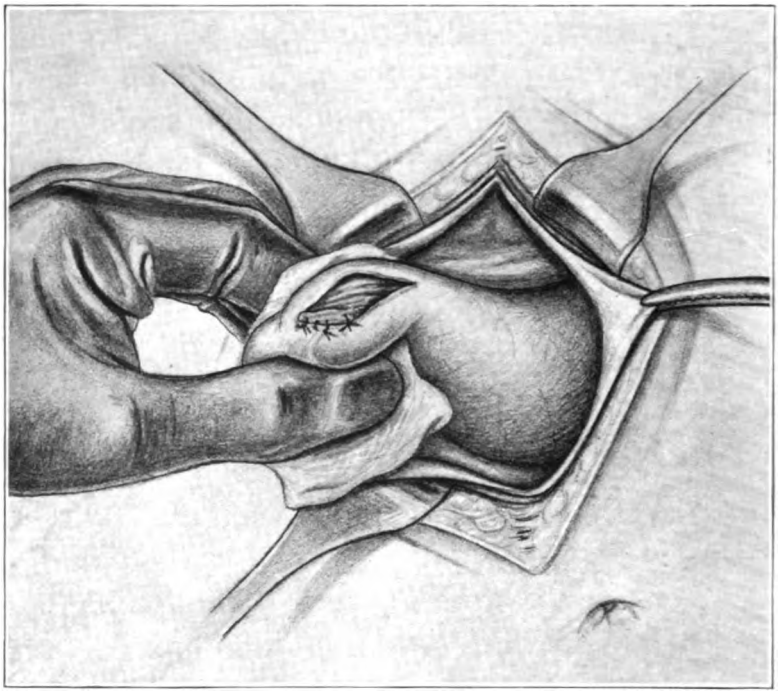

Fig. 4.—Bit of muscle fiber used to control bleeding from pyloric artery.

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increase in each succeeding patient examined. In only two out of 217 cases (including thirty-one gastroenterostomies) which I observed and in which I operated up to April 1, has the anteoperative diagnosis of a tumor at the pylorus proved incorrect. In one of these, a small freely movable right kidney was mistaken for a pyloric tumor, but in the other no satisfactory explanation could be given for the mistake. Both occurred some years ago. I myself believe that it is extremely important to develop the ability to feel the tumor in these cases, as its presence is conclusive evidence of the disease. With this finding along with the usual symptoms of projectile vomiting, loss of weight, peristaltic waves, gastric retention, etc., the diagnosis has been proved correct in more than 99 per cent. of our cases, and for this reason we have not thought it necessary to resort to the roentgen ray as a means of diagnosis in the average case of pyloric stenosis. Many of these babies were admitted to the hospital in such poor condition that immediate operation seemed to offer the only means of saving life. Certainly a delay of from four to eight hours or longer for fluoroscopy or roentgenograms was not warranted when the diagnosis could be established with almost absolute precision if the history was correctly taken and a proper physical examination made. I know of at least one infant that went into a collapse and died while it was being put through a bismuth series. We grant that an occasional vomiting baby is seen in which the history and findings are confusing, when the roentgen ray may be of inestimable value in clearing up the diagnosis.

TREATMENT

As suggested by Holt,[4] congenital pyloric stenosis should be considered as occurring in mild and in severe forms. The determination as to which of these groups

4. Holt, L. E.: Medical Versus Surgical Treatment of Pyloric Stenosis in Infancy, J. A. M. A. 62: 2014 (June 27) 1914; Hypertrophic Stenosis in Infants, ibid. 68: 1517 (May 26) 1917.

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a given case belongs depends on the patient's response to medical treatment. If a patient is observed from the onset of symptoms, or if a reliable history can be obtained as to the duration of symptoms, medical treatment is justified for a period of from seven to ten days, provided the baby does not lose more than 20 per cent. of its body weight during this time. If, at the end of this period, the weight has become stationary and there is a general improvement in the other symptoms, this form of treatment may be continued, always bearing in mind, however, that even though the infant seems to be making satisfactory progress there may be a sudden relapse. If so, the case should then be considered as surgical and operation advised. If, on the other hand, there is no improvement under medical care, or if the improvement is unsatisfactory in that the baby is better one day and worse the next so that at the end of from a week to ten days the sum total is that the baby is worse, the case belongs to the severe group, and immediate operation is indicated.

Considerable experience in the treatment of this disease is necessary in order to acquire the ability to decide with any degree of accuracy in which group a given case should be placed. As congenital pyloric stenosis is after all not a very common disease, there is little opportunity for the general practitioner to gain this experience. For this reason, any baby with persistent forcible vomiting should be seen by the best available pediatrician at the first possible moment. So frequently is the history misleading or inaccurate and the necessary data, such previous weight, lacking that I believe the question of operation should be taken up in every case as soon as the diagnosis is made.

As has already been stated, those cases in which it is very evident that the symptoms are of short duration, and the condition of the baby good, observation under medical care is allowable for a short time, although the physician should be prepared to turn the case over to the surgeon should there be the slightest

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change for the worse. Up to the last few years the results following operative treatment of pyloric obstruction in infants were so uncertain that physicians hesitated to recommend this form of treatment; but now that the technic is simplified and the results uniformly good, these objections no longer hold. Surely no man could persist in the medical treatment of this condition beyond the point already mentioned as permissible when the mortality is stated by the best observers to be anywhere from 10 to 50 per cent. or higher under this form of treatment, and it can be shown that the mortality after operation is a fraction under 2 per cent. in selected cases. In a study of the cases at the Babies' Hospital, Goldbloom and Spence [5] call attention to the fact that out of fifty-one breast fed babies coming to operation with a weight loss of less than 20 per cent., only one died. Strauss [6] recently reported marvelous results following the operative treatment of hypertrophic stenosis in infants. He states that he has operated on 103 unselected patients by a special type of extramucous pyloroplasty with only three deaths—a mortality of less than 3 per cent. The diagnosis was made in each case by the fluoroscope, and in no instance was operation refused because of the poor condition of the baby. From the increasing number of infants with pyloric stenosis admitted to the Babies' Hospital for operation each year, it would seem that the majority of pediatricians now believe that surgery offers more than medicine in the treatment of this disease.

OPERATION

The abdomen is opened through an upper right rectus incision from 1½ to 2 inches in length. When the wound is retracted, the stomach is easily recognized; and if the portion of the anterior wall which

5. Goldbloom, Alton, and Spence, R. C.: Prognosis in Operated Cases of Hypertrophic Stenosis of Pylorus, Am. J. Dis. Child. 19: 263 (April) 1920.
6. Strauss, A. A.: Surgical Clinics of Chicago, February, 1920, p. 93.

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appears is then picked up with anatomic forceps and gentle traction applied, the pyloric end of the stomach with the tumor is quickly brought into view. The tumor is then grasped between the thumb and index finger, and a longitudinal incision varying from 1 to 1¼ inches in length, according to the size of the tumor, is made at about the junction of the upper and middle thirds (Fig. 1). This incision should start just proximal to the duodenum and should involve only about one-half the estimated thickness of the muscular layer. By gently spreading a pair of small, straight forceps inserted into the center of the incision, the undivided portion of the muscle tears exposing the mucous membrane (Fig. 2), and by continuing this blunt dissection the division is carried down along the line of cleavage to the duodenal ring and well up on the stomach. The separation of the muscular layer from the mucous layer should be sufficiently complete to permit the mucosa to protrude freely into the wound (Fig. 3).

Great care should always be used in spreading the muscle at the duodenal end of the tumor, as the change from the thickwalled pylorus to the normal duodenum with its thin muscular layer is very sudden, and there is great danger of opening the mucous membrane at this point. At the proximal end, the tumor gradually merges into the stomach, and there is not so much danger of injuring the mucous layer. Complete division of the tumor with the knife should never be attempted. As a rule there is little tendency to hemorrhage except in the older babies. A small artery at the duodenal end of the incision may require a ligature; or, if this vessel has retracted under the muscular layer, it may be necessary to suture a bit of muscle fiber, easily obtained from the rectus, over the bleeding point (Fig. 4). In the babies—aged 10 weeks and over—coming to operation, the tendency to bleed is much greater. Besides the artery at the lower angle, there is generally another near the stomach end of the incision. In these cases, continuous suture around the

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margin of the incision, supplemented by a bit of muscle or omentum, may be necessary to control the bleeding. I do not believe that it is necessary to attempt to cover the exposed mucosa. After the pylorus has been dropped back into the abdomen, the line of incision is again inspected to make sure that all bleeding points have been controlled. The abdominal wall is closed in the usual way.

ACCIDENTS AND COMPLICATIONS

The duodenum was opened three times in this series of cases. The opening was small in each instance, and was easily closed with fine silk suture reinforced by omentum. Two of the patients made a satisfactory recovery, but the third died of peritonitis on the eighth day. Careful hemostasis of the abdominal wound is very important. Four of our patients lost considerable blood from this source, requiring transfusion in two instances. As many of our patients were admitted to the hospital in desperate condition, it was the custom until recently to give a hypodermoclysis of from 150 to 200 c.c. of salt solution preliminary to operation. We now feel that this was a mistake, and that the tendency to bleed was aggravated by this treatment, especially in the older infants. Smaller quantities, from 50 to 100 c.c. of physiologic sodium chlorid or glucose solution given under the skin, beginning from two to four hours after operation and repeated as indicated, is just as efficacious and is a safer procedure. Transfusion both before and after operation was resorted to in a number of cases, but did not prove of value except in those in which there had been hemorrhage, and in one case in which a deep seated abscess developed following a clysis. Practically all the wounds healed by first intention. Sutures are not to be removed before the tenth day. Feeding is begun one hour after operation. At first, from one to two teaspoonfuls of water, alternated with a similar amount of diluted breast milk, is given and gradually increased until the

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fifth day, when the child should be receiving almost its normal caloric requirements.

The postoperative management of these patients as carried out at the Babies' Hospital was described by Morgan [7] in 1916, and more recently by Goldbloom and Spence. Convalescence in the great majority was without special incident. Loose stools were perhaps the most frequent complication, and were due either to increasing the food too rapidly or to changing from breast milk to a formula, as is often necessary preliminary to discharge from the hospital. Postoperative vomiting is noted as occurring in small amounts or not at all in 107 cases; moderately in twenty-two, and in large amounts in sixteen. Of the patients that died, eleven are recorded as having vomited and nineteen as not.

The average stay in the hospital of the breast fed babies was fourteen days, and of the bottle fed babies twenty-three days. Of the 145 babies discharged as cured, eighty-nine have been seen or heard from in the last two months. All are in excellent health, and with few exceptions are above their normal weight. Eleven are known to have died from one cause or another over periods varying from a few weeks to eighteen months after operation. Forty-five have been lost sight of.

We have been fortunate in obtaining necropsies in two cases in which the patient died of pulmonary conditions a year and a half after operation. The pyloric tumor had entirely disappeared in both instances, and, with the exception of light omental adhesions at the site of the scar, the pylorus appeared normal in every way.

CONCLUSIONS

1. If a satisfactory history can be obtained, and if the findings of a proper physical examination are correctly interpreted, the diagnosis of congenital hyper-

7. Morgan, E. A.: The Postoperative Management of Pyloric Stenosis, Am. J. Dis. Child. 11: 245 (April) 1916.

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trophic pyloric stenosis should be made in practically every case.

2. If the patient is observed from the onset of symptoms, medical treatment may be tried for a period of not longer than ten days, provided the weight loss does not exceed 20 per cent. during this time. If, at the end of this period, the child does not show definite improvement, operative interference is indicated. Any patient, continued under medical care, and suffering a relapse should be operated on at once.

3. All cases in which there is a history of a period of ten days or longer in which the data as to previous weight are lacking—and in which the patient is not in very good condition—should immediately be classed as surgical.

4. The mortality among patients coming to operation within four weeks from the onset of symptoms is less than 8 per cent.

5. The results following the Fredet-Rammstedt operation are permanent and the cure complete.

424 Park Avenue.

ABSTRACT OF DISCUSSION

DR. DEAN LEWIS, Chicago: I have performed twelve gastro-enterostomies for the relief of congenital pyloric stenosis. Three of the babies died. In one case the gastro-enterostomy perforated, in another the abdominal wall opened on the fifth day, the baby dying from peritonitis, in the third case the baby did not recover, although no definite cause of death could be established. All the patients who recovered had a stormy convalescence. In the thirteenth case, the condition of the baby was so bad that I did not think it wise to perform a gastro-enterostomy and the operation under discussion was performed. This baby recovered rapidly and without any untoward symptoms. I have performed four of these operations since this first one. The babies have recovered. Two other cases in which I operated presented all the symptoms of congenital pyloric stenosis, with the exception of the tumor. These patients were operated on but as no tumor was found the abdomen was closed. Both babies recovered. This operation is simple and can be performed quickly. It meets the conditions and I cannot see how it can be improved on. The incision should be made through the

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right rectus muscle and should be carefully closed in layers. Opening of the incision has occurred not infrequently when it has been made in the linea alba.

Dr. R. Hill, St. Louis: In one thousand children born in a foundling hospital with which I am connected we found five cases of pyloric stenosis. From the increasing number coming in for operation I cannot but believe that the condition has been very generally overlooked, and that physicians are just beginning to recognize it. In regard to the method of operating: formerly I did a gastro-enterostomy. The babies who were brought in early were in fairly good shape and recovered. Then they began to bring in children practically dead and we lost quite a number. I did fourteen of these operations. One child, a premature baby, weighed 3 pounds 15 ounces, I did a gastro-enterostomy. The baby recovered and is well today, although seven years have elapsed. I have done twenty-two Rammstedt operations. Twenty-one patients recovered and one died. This baby had suppression of urine for twenty-four hours before it was admitted to the hospital, with convulsions, and a temperature of 103 F. This child never urinated after the operation and died of uremia. We saved one very sick baby by injecting glucose into the superior longitudinal sinus. We have found this to be of value in some of these very bad cases. I have had to reopen the abdomen twice. In one case it was due to not making the opening larger. I made a single incision along side of the first one and the child recovered. In the second case the child had convulsions before being brought in, artificial respirations had to be resorted to before the operation, and still the wound looked fine at the end of the fourth day. On the sixth day, while doing artificial respiration, the wound broke open, the child developed obstructive symptoms and we had to reopen the abdomen. We found adhesions, released them and the child got well.

Dr. A. A. Strauss, Chicago: Too much credit cannot be given Dr. Downes for calling attention to the Rammstedt operation. Dr. Downes brought out that there is a distinct field in the surgery of children and infants. I have treated 163 cases of congenital pyloric stenosis, with three deaths. I operated in 107, with three deaths. The remaining fifty-six patients were treated medically. I insist on a roentgen-ray and a fluoroscopic examination in every case. Such examinations show definitely not only if there is a congenital pyloric stenosis, but also if the patient should be treated medically or surgically. If from 70 to 80 per cent. of the bismuth meal goes through within four hours, there will undoubtedly be recovery in that case by medical treatment, irrespective of any clinical symptoms or tumor. If less than 70 per cent. of the bismuth goes through, it is an indication for operation. A tumor was found in the 107 cases in which I operated.

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The fifty-six babies treated medically recovered, and not a single one returned for operation.

If the Rammstedt operation were performed as he described it, the mortality would range from 30 to 50 per cent. The Rammstedt procedure does not release the obstruction sufficiently, and for this reason, the patient, following an operation, vomits from three to five days. If he is in a moribund condition, this postoperative vomiting is sufficient to cause death. The procedure which I devised is a reconstruction of the abnormal condition of the pylorus into a normal one. It frees the infolding mucosa and releases the obstruction completely. For this reason the moribund infant will not vomit, but will retain its food. The mortality rate of my operation is less than 3 per cent. I know of one surgeon who has operated in nineteen cases after my method, without a death, and another, who has operated in twenty-three cases, with one death.

Dr. L. T. Le Wald, New York: I wish to emphasize the frequency of this condition in children and the value of the roentgen ray in diagnosis. Of all the gastro-intestinal examinations I have made in the last ten years, I know of no condition in which the diagnosis is so definite.

Dr. Arthur D. Bevan, Chicago: I have been impressed by the importance of doing all these operations under local anesthesia. I would go so far as to say that congenital pyloric stenosis should under no circumstances be done under a general anesthetic. The Rammstedt operation is so much easier, so much safer that it has revolutionized the whole subject. Whenever the choice lies between ether anesthesia and a gastro-enterostomy and local anesthesia and the Rammstedt operation, one should not hesitate to choose the latter. I would like to put myself on record as saying to the surgeons of the country that under no circumstances should a case of congenital pyloric stenosis be operated under a general anesthetic. It can be done better and with absolute safety under local anesthesia.

Dr. J. L. Ransohoff, Cincinnati: The Rammstedt operation has the appeal of complete simplicity and absolute efficiency. It is to my mind one of the most perfect operations devised in surgery and all modifications are unnecessary. I did the gastro-enterostomy before the Rammstedt operation and several Rammstedt operations since. I had one death. This was due to the opening of the duodenum, a very unpleasant complication. I should like Dr. Downes to tell us his exact maneuver in closing these wounds of the duodenum. I had the opportunity of making a postmortem examination of a child six months after a successful Rammstedt operation. This child died suddenly of enlarged thymus. The necropsy revealed a perfect pylorus without a trace of tumor. There was a linear scar at the site of the old incision, no adhesions

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and the scar was completely covered with peritoneum. Subsequently, in another case where I had done a Rammstedt operation, the mother heard of the result in the case of the child that died of enlarged thymus and became very much alarmed. She brought the child to me and a roentgenogram showed an enlarged thymus. Dr. Palmer, of Cincinnati, among twenty cases has found five cases of enlarged thymus.

DR. W. A. DOWNES, New York: I do not subscribe to the views expressed by Dr. Bevan regarding the use of local anesthesia in these cases. I have tried it in various cases without very satisfactory results. It is important not to allow the stomach to extrude and not to let the intestine to come out into the wound, and with a child struggling and crying, as it would with local anesthesia, I do not see how this could be prevented. I always use ether, never chloroform. I cannot make a statement regarding the frequency of enlarged thymus in these cases.

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THE SURGICAL TREATMENT OF BRAIN ABSCESS*

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A brain abscess may pass through three distinct phases, the initiatory, the quiescent, and the terminal.[1] It should be operated on in the quiescent stage, not in the initiatory or terminal, as is frequently done.

During the initiatory stage the patient is more likely to present symptoms of diffuse encephalitis and meningitis than of localized tissue destruction. In many instances the disease passes into the quiescent stage with little trouble except for symptoms of intracranial pressure, which are difficult to distinguish from those produced by brain tumor, or it may be interrupted by death in a comparatively short time.

During the quiescent stage, the abscess usually presents a thickened capsule and the inflammation occasionally quiets down permanently. But if the lesion is not operated on, a secondary infection usually develops which stirs up the old process, produces acute encephalitis, and causes death.

Holmes[2] found that brain abscess is more likely to occur during the second and third decades of life than during the first, and that solitary tubercles are more common than abscesses in children under 5 years of age.

Gowers,[3] in a study of 223 cases of brain abscess, found that 10.7 per cent. occurred in patients less than

*From the Section of Neurologic Surgery, Mayo Clinic.

1. Macewen, W.: Pyogenic Infective Diseases of the Brain and Spinal Cord, New York, the Macmillan Company, 1893, 354 pp.
2. Holmes, J. B.: Multiple Abscesses of the Brain in Infancy, Arch. Int. Med. 17: 591-606 (May) 1916.
3. Gowers, quoted by Holmes (Footnote 2).

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10 years of age, and Okada,[4] in a collection of 141 cases, found that 11.6 per cent. occurred during the first decade, and 37.3 per cent. and 30.8 per cent. during the second and third decades of life, respectively. He also showed that the frequency of cerebellar abscess during the first decade of life was one half that of cerebral abscess. Heimann,[5] in a study of 535 cases of brain abscess of otitic origin, stated that he found only three (1 per cent.) in children under 5 years of age.

The principal causes of pyogenic abscess are middle ear disease, frontal sinusitis, and trauma. The abscess produced is single, and situated in the temporosphenoidal or frontal lobes, or at the point of the injury to the skull. A rather small percentage is situated in the cerebellum. Heimann reports a series of 570 cases of brain abscess of otitic origin, in which 457 were due to chronic otitis media and 113 to acute otitis media; this is significant evidence that brain abscess is prone to occur in chronic suppurative conditions, a theory which is borne out not only in cases of chronic otitis media and frontal sinusitis, but also in cases of empyema, osteomyelitis and general septicopyemia.

A brain abscess may arise from an infected area and extend into the brain by contiguity, or it may develop at a distance from its etiologic factor and be a part of a hemotogenous or lymphatic infection. Frontal lobe abscess following frontal sinusitis with osteomyelitis, and temporosphenoidal abscess following otitis media, are illustrations of infection by contiguity. On account of the good blood supply to the cortex, however, and the diminished circulation in the white substance, an abscess usually develops subcortically and extends toward the middle of the brain.

4. Okada, W.: Diagnose und Chirurgie des otogenen Kleinhirnabszesses, Klin. Vortr. a. d. Geb. d. Otol. **10**: 313-450, 1900.

5. Heimann, T.: Ein Fall von akutem, otitischen Schläfenlappenabszess (induziert durch Otitis media suppurativa acuta arteficialis; Einiges zur Statistik der otitischen Hirnabszesse), Arch. f. Ohrenh. **67**: 1, 1905-1906.

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During the initiatory stage, the process is more likely to be encephalitis or meningitis than cell destruction and pus formation; therefore very little can be accomplished by surgical intervention, as the encephalitis frequently continues and produces death. If the process becomes circumscribed and a true abscess forms, the encephalitis generally subsides, since the capsule becomes thickened and acts as a protection against the absorption of toxic materials. The brain abscess then produces symptoms of intracranial pressure and localization similar to those produced by tumor in the brain. The symptoms, such as delirium, coma, stertorous breathing, meningismus, dilated pupils, rapid pulse and paralysis, which are usually considered diagnostic of brain abscess, are symptoms manifested in the terminal stage, indicative of abscess with diffuse encephalitis, which rarely can be checked by surgical treatment.

REVIEW OF TWENTY-SIX CASES

This study is a review of twenty-six cases of brain abscess examined at the Mayo Clinic during the last five years; the diagnosis in twenty-three instances was verified either by operation or by necropsy. For the purpose of detailed study the twenty-six cases are divided into two groups, nonsurgical and surgical cases.

Nonsurgical Cases.—Of the seventeen patients who were not operated on, seven died shortly after admission or during the time of observation. Seven had been operated on previously for chronic empyema or lung abscess, or they presented symptoms of bronchiectasis or chronic tuberculosis; five of the seven died; necropsies were performed on four; one patient died at home. Two patients recovered (the latter are necessarily uncertified cases). Three patients died following a radical mastoid operation for chronic otitis media with subdural abscess. They belonged to a group of thirty-six cases in which the radical mastoid

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operation was done for chronic otitis media associated with some form of subdural abscess.

Surgical Cases.—Nine of the twenty-six patients were operated on for brain abscess; five recovered, and four died shortly after the operation. Of the five patients who recovered, four are now living; one died two years following operation; the cause of death was not reported to us.

Etiology.—Five of the twenty-six cases were traceable to chronic otitis media with acute exacerbation, six to frontal sinusitis, two to frontal sinusitis with osteomyelitis, four to injury of the skull, five to chronic empyema, one to chronic empyema with septicopyemia, one to old pulmonary tuberculosis, one to lung abscess, and one to bronchiectasis.

Location of Abscess.—The abscess was located in the frontal lobe in fourteen patients (three uncertified); one patient died after dismissal from the clinic, and two slowly recovered without operative treatment. In four patients the abscess was situated in the temporal lobe, in two in the temporosphenoidal lobe, in one in the occipital lobe, in two in the cerebellar lobe, in one in the midbrain, in one under the temporal lobe, and in one on the cortex, associated with encephalitis.

Symptoms.—Thirteen patients complained of headache, ten of nausea or projectile vomiting, four of blindness, twelve of jacksonian epilepsy, four of grand mal epilepsy, fourteen of paralysis, sixteen of hebetude or coma, two of injury to the skull, nine of meningeal irritation, and ten of fever.

Clinical Findings.—The urinalysis was negative for all but four patients; these showed symptoms of acute nephritis. The average white cell count for the entire group was 16,000; in a few instances the leukocytosis was normal. Since the diagnosis was uncertain during examination, except for the increased intracranial pressure, the spinal puncture was not done in all cases. Whenever the abscess was not associated with diffuse

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encephalitis or meningitis, the cell count was normal: from two to five lymphocytes to each cubic millimeter. In cases of meningitis with brain abscess, the spinal fluid was cloudy and contained as many as 108,000 leukocytes and lymphocytes to each cubic millimeter. Spinal fluid and blood Wassermann tests were positive in two of the twenty-six cases; this is interesting in that neither of these two patients had any corroborative symptoms of syphilis. Choked disks, ranging from 1 to 7 diopters, were present in nine cases. One patient with a fifteen months' history of brain abscess following a frontal sinusitis had a secondary atrophy with total blindness. Local tenderness was present in twelve cases; in four it was not over the abscess, but a confirmatory symptom in eight of this group. Partial or complete paralysis was present in fourteen cases. Fifteen of the twenty-six cases presented symptoms of mental disturbance, such as lack of attention and cooperation, loss of memory, delirium and coma.

A résumé of the findings reveals urinalysis usually negative, a slight leukocytosis, and if the abscess is unattended with meningitis or cortical encephalitis, a negative spinal puncture. One third of the patients studied had choked disks, ranging from 1 to 7 diopters, one third had local tenderness over the abscess, and one half had a motor or mental impairment.

The duration of the symptoms varied from three days to three years, and each case followed one of three distinct courses. Sixteen patients had an average duration of symptoms of thirty-two days; four of these were operated on for brain abscess and promptly died. The five who recovered following a drainage of the abscess had an average duration of symptoms of six months. Five patients had an average duration of twenty-seven months, two slowly recovered, and three died; two developed secondary infection and encephalitis, and one received an injury which ruptured an old abscess into the ventricle.

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The sixteen patients were in the initiatory stage which did not pass into the quiescent stage. Those who were operated on and recovered were treated in the quiescent stage when the immunity was the highest. The last five patients fall into the terminal group in which an occasional patient recovers without operation, but the chances are greater that a secondary infection and death will occur.

REVIEW OF SURGICAL CASES

Six of the nine patients operated on were explored through an osteoplastic flap, two through a skull defect, the abscess being within close proximity to the site of the injury, and one through a subtemporal decompression, which was not located because of insufficient exposure.

RESULTS IN TWENTY-SIX CASES OF BRAIN ABSCESS

Patients		Patients	
Operated on (35 per cent. of 26)	9	Not operated on (65 per cent. of 26)	17
Died (45 per cent. of 9)	4	Died (89 per cent. of 17)	15
Cured (33.3 per cent. of 9)	3	Cured (5.8 per cent. of 17)	1
Improved (22.2 per cent. of 9) (with epilepsy)	2	Improved (5.8 per cent. of 17) (with epilepsy and slight motor impairment)	1

A brain cannula was used to locate the abscess; the pus and broken down brain material were removed by suction, the cavity irrigated with saline solution and then packed loosely about the tube drains with iodoform gauze; in one case, tubes without gauze were used. In all but one case the pus was very thick and ropey and contained pathogenic organisms; in the one the pus was sterile; this patient gave a fifteen months' history of trouble.

The convalescent course of the patients, save one, who recovered following the operation, was uneventful. This patient developed a local meningitis, osteomyelitis, and infection in the wound; a considerable portion of

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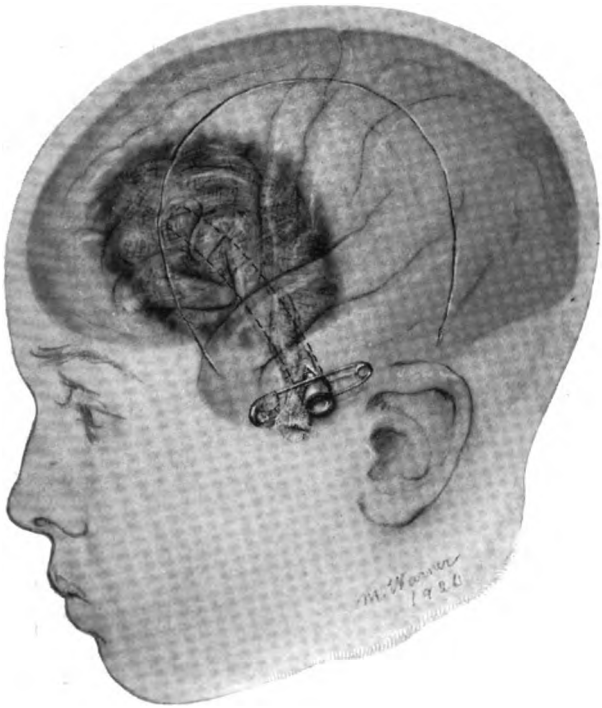

Fig. 1 (A 192143).—Drainage through the base of the osteoplastic flap of a large subcortical abscess of the left frontal lobe containing 6 ounces of pus. The abscess developed subsequent to an acute otitis media.

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Fig. 2 (A 192143).—Patient three years after operation illustrated in Figure 1. Recovery was complete.

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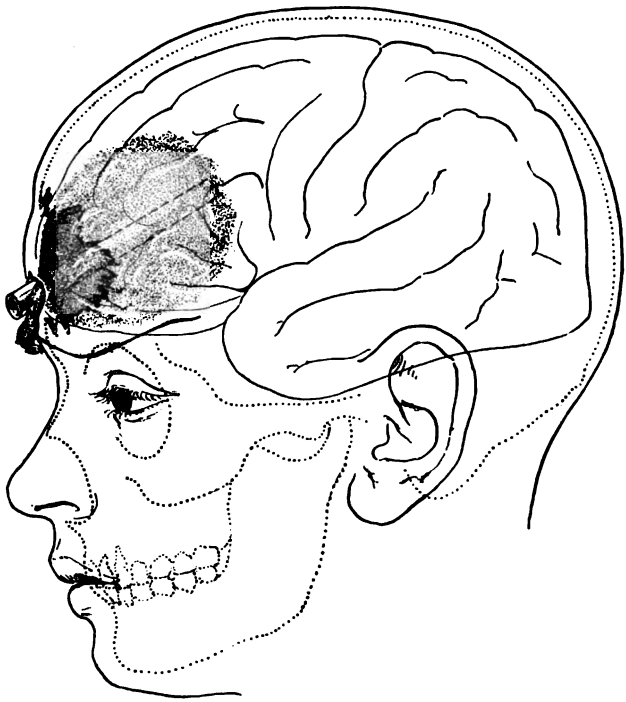

Fig. 3 (A 206923).—Drainage of an abscess of the left frontal lobe through a skull defect caused by a kick from a horse. The frontal bone was crushed, and infected spicules of bone were driven into the brain substance.

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Fig. 4 (A 206923).—Three months after operation (Fig. 3); recovery was complete except for a cerebral hernia which has now receded.

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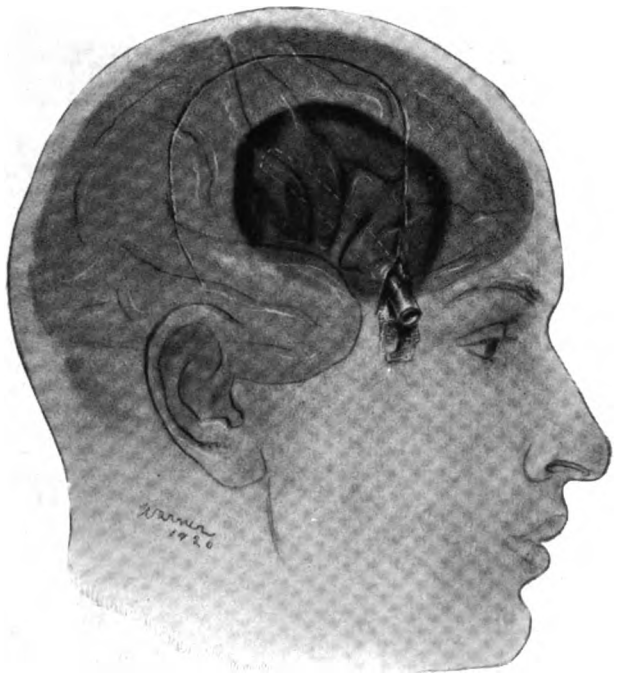

Fig. 5 (A 270162).—Drainage of a subcortical abscess of the right frontal lobe through a small decompression at the angle of the wound. The abscess, which developed subsequent to a frontal sinusitis, was of fifteen months' duration and contained sterile pus. Patient recovered except for secondary atrophy.

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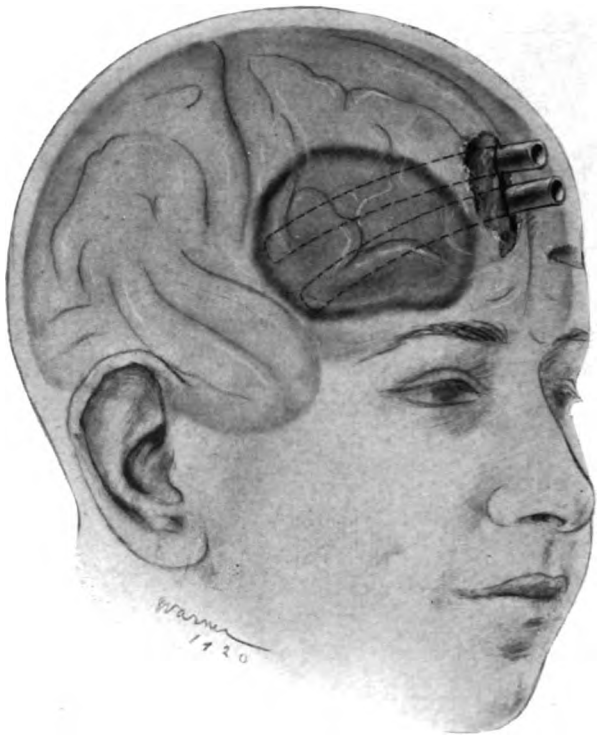

Fig. 6 (A 112525).—Drainage of an abscess of the right frontal lobe through a skull defect which was the result of an osteomyelitis following frontal sinusitis.

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Fig. 7 (A 112525).—Patient ten days after drainage of the frontal lobe. Abscess (Fig. 6) with the drains in place.

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Fig. 8 (A 112525).—Patient had an uneventful convalescence.

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the skin was destroyed, exposing an area of the bone flap 6 by 9 cm. This patient presented a very interesting and rather singular picture in that we were experiencing considerable difficulty in stimulating granulation over the denuded area, when, accidentally, the patient bumped her head and fractured the outer table of the exposed bone, on removal of which the wound healed rapidly, and skin-grafting was unnecessary. The principle of this healing is of value in the treatment of exposed areas of the skull in cases of gummatous osteitis, and in denuded areas following traumatic loss of scalp. If the sequestrum or outer table is removed, the wound granulates quickly and usually heals without skin-grafting.

Another striking feature following drainage of a brain abscess is the rapidity and entirety of mental and motor restoration. This may be explained by the fact that the abscess usually develops within the white substance of the brain with a tendency to expand the part involved rather than produce actual destruction of brain substance, and on drainage of the abscess the cavity collapses, the edema subsides, the circulation improves, and the function returns.

CONCLUSIONS

1. The four principal etiologic factors in the formation of abscess of the brain are otitic infection, frontal sinusitis, injury to the skull, and hematogenous infection. Brain abscess is usually single, except when it is of hematogenous origin associated with a general pyemia, and then frequently it is multiple.

2. A brain abscess in its course may pass through the initiatory, the quiescent, and the terminal phase. The different phases can be determined more definitely from the history and duration of the complaint than from the physical findings.

3. If the abscess has developed by contiguity, it should be explored through the area of infection; but

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if the abscess is remote from the source of infection, it should be explored and drained through an osteoplastic flap craniotomy.

4. Surgical treatment is of little value in the initiatory or terminal stages, or in the presence of meningitis, but it is of great benefit during the quiescent stage. If there is doubt as to the differential diagnosis of brain tumor and brain abscess in the quiescent stage, it is advisable to explore rather than to perform a decompression operation for intracranial pressure or to wait for terminal symptoms.

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SURGICAL EXPERIENCES WITH AN INTRACRANIAL APPROACH TO CHIASMAL LESIONS

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BALTIMORE

In May, 1914, an intracranial operation for exposing chiasmal lesions was devised and successfully performed on a patient with an hypophysial cyst. It was unlike the procedure of Krause, McArthur and the earlier operation of Frazier, in that it was an intradural rather than an extradural approach. It antedated the later operation of Frazier and the procedure of Adson—operations which, although differing in some details, are in principle the same. It has been consistently employed in lesions suitable for its use, first, because, at the time it was devised a serious trial of an intracranial approach had never been made, and second, because of the desire to learn whether such an approach offered more in the treatment of chiasmal lesions than does the popular nasal approach. Between 1914 and 1918, thirty-seven patients with chiasmal lesions have come to us for treatment. Six patients were not treated, either because operation did not seem indicated or because they refused operation. On two patients a simple decompressive craniotomy was performed for the relief of pressure symptoms; on five patients a transsphenoidal operation was performed, and on twenty-four patients the intracranial operation I shall subsequently describe was performed. On six of these patients a second intracranial operation was performed from one and a half to three years after the primary operation.[1] The series, then, is rather small; yet from a survey of the literature, it is the largest individual series in which an intracranial operation has been consistently used.

What knowledge have we gained by an intracranial exposure of the nature, the direction of growth, the clinical aspects and the accessibility of chiasmal lesions? How does this knowledge apply in determining what route—intracranial or transsphenoidal—to use in those who present symptoms and signs of a chiasmal lesion?

1. Of the thirty operations performed on these twenty-four patients, nine were performed by Dr. W. E. Dandy and twenty-one by myself.

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THE NATURE OF CHIASMAL LESIONS

The chiasmal lesions—using the term in a broad sense to indicate those tumors or cysts which arise in or about the optic chiasm—include the hypophysial tumors and cysts, the optic chiasm tumors and the suprasellar tumors and cysts. In our experience hypophysial lesions occurred in 73 per cent., suprasellar lesions in 24.3 per cent., and optic chiasm lesions in 2.7 per cent. of the cases.

These percentages probably more truly represent the proportion of these lesions than do those in the literature at present. Fully 90 per cent. of the cases in the literature are reported as hypophysial lesions; yet when we read the operative reports and the findings in necropsy examinations it is clear that many cases reported as hypophysial and in which operation was performed by the nasal route were suprasellar lesions. This point is of considerable importance; it indicates the difficulty that has been experienced in differentiating between hypophysial and suprasellar lesions; and it suggests that surgeons have heretofore been attacking indiscriminately by one approach all lesions about the chiasm.

Pathologically, the lesions in our series were made the subject of a special study by Duffy, the results of which are: Of the twenty true hypophysial lesions in which operation was performed, solid tumors occurred in 80 per cent., cystic tumors in 20 per cent. In 100 per cent. of the solid tumors the diagnosis of adenoma was made. In all of the cystic tumors, adenomatous tissue was demonstrable in the walls of the cysts. True cysts of the hypophysis therefore did not occur in this series. Of the seven suprasellar lesions in which operation was performed, three were solid tumors (gliomas of the anterior perforated space, or base of the brain), three were cysts arising from cell inclusions of the craniopharyngeal duct, and one a solid and cystic tumor (glioma) arising from the base. The one lesion of the optic chiasm in this series was a sarcoma arising from the nerve sheath. These findings emphasize what the more recent literature on the pathology of chiasmal lesions has indicated; namely, that with increasing knowledge more and more cases which were previously diagnosed as carcinoma, sarcoma, epithelioma, malignant adenoma, and endothelioma of the hypophysis are now recognized as adenomas, and that perhaps 50 per cent. of the suprasellar lesions are cysts arising from embryonic inclusions of the craniopharyngeal duct.

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DIRECTION OF GROWTH

It is well known that in the early period of their growth hypophysial lesions are confined within the sella turcica. Sooner or later, however, they extend beyond the confines of the sella and their growth is either downward, toward or into the sphenoidal sinus, or upward into the intracranial chamber. It has been assumed, from the fact that at transsphenoidal operations the floor of the sella turcica has been found thinned or completely absent, that the direction of growth is primarily downward; and one of the arguments used in favor of the transsphenoidal approach has been that it permits, by removal of the floor of the sella turcica, the downward growth of hypophysial lesions. It is indeed true that hypophysial lesions are found filling the sphenoidal sinus; but that their growth has been primarily in this direction, or that it has occurred to a greater extent in a downward rather than an upward direction seems to us incorrect. In my examination of reports in the literature of cases in which the patients died after transsphenoidal operations, I have found that in practically 100 per cent. of the cases—even though the floor of the sella turcica has been eroded and the tumor fills the sphenoidal cavity—a far larger proportion of the tumor has extended into the intracranial chamber. Moreover, our personal experience in viewing hypophysial lesions through an intracranial approach has demonstrated two important points: First, that before the floor of the sella turcica has been eroded and even before the posterior clinoid processes have become destroyed, the hypophysial lesion has broken through the diaphragm of the sella turcica and become an intracranial growth; and second, that even though the floor of the sella turcica is removed by early operation conducted through the nose, the lesion will not, or only to a slight extent, grow downward, but will in spite of these measures grow upward into the intracranial chamber. It seems evident to us, therefore, that the diaphragma sellae offers the least resistance to the growth of hypophysial lesions and that their growth is primarily and always in greatest extent upward and into the intracranial chamber.

Their direction of growth after hypophysial lesions have broken through the diaphragma sellae has been the subject of investigation, and from an operative standpoint the determination of this point is of great importance. Obviously, hypophysial lesions may grow directly upward toward the base of the brain; they may grow forward,

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appearing in front of the optic chiasm and between the optic nerves; they may grow backward behind the chiasm and extend posteriorly in the cleft between the base of the temporal lobe and pons; and finally, they may grow laterally into the temporal fossae and involve the cavernous sinuses. From the literature, we gather that hypophysial tumors have been found at necropsy extending in all these directions; but owing to the incompleteness of the reports, and to the fact that postmortem examinations have been made chiefly in late cases, it cannot be determined in what special direction, if any, these lesions primarily grow. Cope, on anatomic grounds and from a study of the literature, concludes that the early intracranial extensions of hypophysial tumors are forward in front of the optic chiasm; and our personal experience is overwhelmingly in support of his findings. In twenty-two intracranial exposures of true hypophysial lesions the intracranial extension was forward—appearing in front of the optic chiasm and between the optic nerves—in twenty instances; and was forward and laterad in two instances. In four of the cases in which the lesion appeared forward, a second exposure made one to two years after the primary, again disclosed the lesion appearing forward. Extension backward did not occur in our moderately early cases. Our necropsy examinations confirm these operative findings. Moreover, the diagrams of Schloffer and the more recent diagrams of the operative findings in Adson's six cases, support our observations; and I believe it may be stated, therefore, that the early intracranial extensions of hypophysial lesions are forward and appear in front of the optic chiasm between the optic nerves. From the point of view of operative procedure, the importance of this point is that the forward intracranial extensions of hypophysial lesions are readily accessible by intracranial operations.

The suprasellar and the chiasmal lesions need not be discussed from this standpoint. They are primarily intracranial tumors and can be satisfactorily approached only by an intracranial route.

CLINICAL ASPECTS OF CHIASMAL LESIONS

From a clinical point of view, cases which present symptoms of a chiasmal lesion may be roughly grouped as follows:

1. A group of cases which present evidence of disturbed hypophysial function either on the side of lessened activity (obesity, sexual abnormalities, drowsiness); on the side of increased activity (early

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acromegaly); or mixed types. There are no discomforts, such as headache; and there are no neighborhood symptoms (pressure on the chiasm). The sella turcica may be normal in size, it may be small or it may be enlarged. It does not show any destruction. Up to the present time, surgery in this group of cases has not been considered indicated.

2. A group of cases with glandular symptoms (acromegaly or mixed glandular symptoms) and with pronounced sellar headaches. There may be slight visual disturbances, as evidenced by contraction of the visual fields, but no hemianopia. The sella may be enlarged but shows no evidence of destruction nor alteration in the distance relations between anterior and posterior clinoid processes. It has been assumed that the struma, if such it be, is confined to the sella turcica and has not invaded the intracranial space. Surgery may attempt in this group to relieve the headaches. Whether it should attempt more, such as the removal of a part of the gland, has seemed doubtful.

3. A group of cases with pronounced "neighborhood" symptoms (various forms and degrees of hemianopia, optic atrophy, diminished visual acuity, ocular palsies). There may be evident glandular symptoms of the acromegalic, Froelich, or mixed types; or glandular symptoms may be absent. The sella turcica is enlarged and has undergone varying grades of destruction. This group of cases has been considered most favorable for surgery, and operative procedures—in the vast majority of cases conducted through the nose—have been directed to relieving the neighborhood symptoms; only incidently to correcting secretory abnormalities.

4. A group of cases which in addition to the signs and symptoms just outlined (Group 3), present signs of increased intracranial tension (headache, vomiting, choked disk superimposed on atrophy). The lesion originating in or about the sella has given rise to an intracranial extension sufficiently large to produce general pressure and sometimes focal symptoms. Surgery in this group has chiefly attempted to relieve general pressure symptoms for it has assumed that the primary lesion is inoperable.

The four groups of cases thus far considered represent successive stages in the growth of true hypophysial lesions.

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5. A group of cases in which the lesion is primarily suprasellar in origin. The lesion arises either from cell inclusions of the craniopharyngeal duct or from the base of the brain and causes pressure on the chiasm and hypophysis from above. There may be the neighborhood symptoms described under Group 3 and glandular symptoms due to hypophysial deficiency. The sella turcica may be normal, enlarged, flattened, partly or completely destroyed. In the later stages, there are in addition general pressure symptoms due often to an internal hydrocephalus from occlusion of the third ventricle. Surgery in this group of cases has thus far been unsuccessful.

6. A group of cases—exceedingly small—in which the lesion arises from the optic chiasm itself. Only one such case has occurred in our series, and I have been unable to find records of similar cases. They may be grouped with the suprasellar lesions, both from the standpoint of symptomatology and treatment.

Let us discuss these clinical groups from the standpoint of our operative findings in order to discover to what extent the clinical signs we have relied on actually indicate the size and extent of the lesion. We have no data on the first group, for in the presence of secretory abnormalities alone and in the absence of headache or visual disturbances we have not felt justified in resorting to surgery. In the second group of cases, it has been assumed that the absence of visual disturbances and the absence of destruction of, or alteration in, the distance relations between the clinoid processes are indications that the hypophysial lesion is confined to the sella turcica. Such, however, is not the case. We have found by an intracranial exposure that in the total absence of visual disturbances and in the absence of destruction of, or alteration in, the distance relations between the clinoid processes, hypophysial tumors have broken through the diaphragma sellae and presented moderate and even large intracranial extensions. The intracranial extensions may even appear forward between the optic nerves. Such has been found to be the case, for example, in typical acromegalics presenting no symptoms or signs other than so-called sellar headaches. In the third group which clinically present "neighborhood" symptoms and enlargement and varying grades of destruction of the sella turcica, there has invariably been a large intracranial extension of the hypophysial growth; so large, indeed, as to

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make the nasal approach—almost invariably used in these cases—seem utterly futile. In the fourth group the intracranial extension is again invariable and even larger than in the third group. In the fifth group, the lesion is primarily intracranial; but here the question

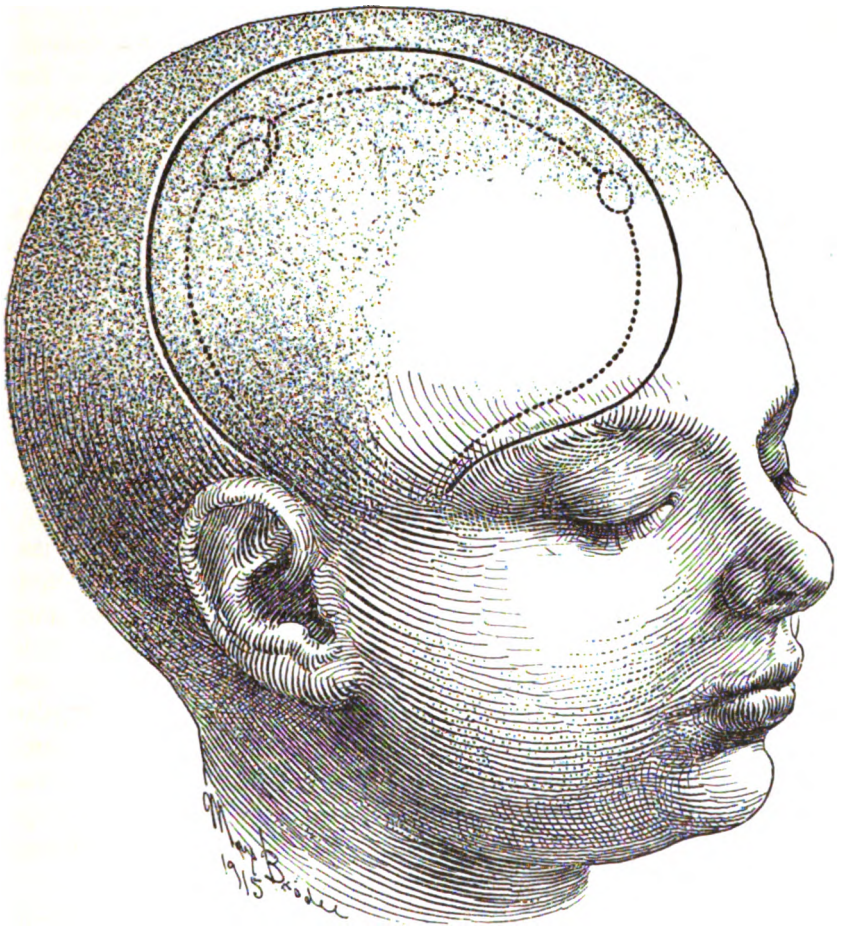

Fig. 1.—Outline of scalp and bone flap in the approach to the chiasmal region.

of differential diagnosis between hypophysial and suprasellar lesions arises. Our experience confirms the previously recognized fact that in general the *early* suprasellar lesions give rise to visual disturbances

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before there is much alteration in size or shape of the sella turcica. Moreover, in three of our cases particles of bone in the walls of suprasellar cysts gave rise to shadows above the sella turcica. But in the later stages of these lesions, symptoms and signs exactly like those of hypophysial lesions are the rule; and in the presence of neighborhood symptoms, glandular symptoms, and varying grades of enlargement and destruction of the sella turcica, a differential diagnosis is indeed difficult. That it cannot with any certainty be made has been our experience; that it has often not been made by others is clearly indicated from a study of the necropsy records in the literature.

Exclusive of Group 1, in which surgery at the present time is not considered indicated, every patient therefore that presents symptoms of a chiasmal lesion has in all probability an intracranial growth. The only possible exceptions are the cases falling in Group 2, and in these, while we have not a sufficient number of cases to speak positively, we know that an intracranial growth may be present.

THE ACCESSIBILITY OF CHIASMAL LESIONS

With the exception of a few dissenting views, surgical opinion thus far has been overwhelmingly to the effect that chiasmal lesions cannot be successfully attacked by an intracranial approach. Of this opinion have been those who have in largest measure contributed to our knowledge of the clinical manifestations and surgical treatment of chiasmal lesions. Their views may be thus roughly summarized:

The transsphenoidal approach will always remain the operation of choice. The intracranial route is not feasible for tumors confined to the sella turcica. It can be only palliative in the majority of cases since it does not become the operation of choice until the tumor is far advanced and since it will be impossible to remove the part of the tumor lying in the sella turcica. It fails to cope successfully with suprasellar lesions.

Our experience is at variance with these views. From the standpoint of accessibility every chiasmal lesion excepting the portions of hypophysial tumors which have extended far behind the chiasm may be exposed by an intracranial route. Tumors entirely confined to the sella turcica (rare, as we have shown) or portions of tumors within the sella turcica are easily accessible when properly approached and are

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susceptible of removal. Tumors which have passed beyond the confines of the sella are not only accessible but their size and their operability can be determined. Cysts of the hypophysis are readily accessible, for they, as the solid tumors, appear forward and are as readily susceptible of drainage or removal as by the transsphenoidal approach. Suprasellar lesions are accessible, as are the true chiasmal lesions; tumors which cannot be approached by the nasal route. From the standpoint of accessibility, we would reverse the opinion of those just quoted and say that an intracranial approach best exposes and can most adequately deal with the greatest number of chiasmal lesions; and that the transsphenoidal approach should be considered only in those early cases—Group 2—in which there are sellar headaches but no neighborhood symptoms.

Our surgical experiences with an intracranial approach to chiasmal lesions have then been productive of the following observations:

1. The proportion of suprasellar lesions to hypophysial lesions is greater than the literature would indicate and that therefore a larger number of chiasmal lesions must be approached by an intracranial route.

2. The great majority of hypophysial lesions are adenomas, and of these 80 per cent. are solid and 20 per cent. are cystic tumors, and that probably 50 per cent. of the suprasellar lesions are cysts susceptible of drainage.

3. The primary direction of growth of hypophysial lesions is toward the intracranial chamber; and the intracranial extensions are primarilly forward in front of the chiasm and between the optic nerves—in a direction therefore which makes them accessible by an intracranial approach.

4. The absence of visual disturbances and destruction of the clinoid processes are no index that the hypophysial lesion has not broken through the sellar diaphragm and become an intracranial growth; that *with* visual disturbances and destruction of the clinoid processes the lesion is invariably an intracranial growth.

5. The differential diagnosis between hypophysial and suprasellar lesions at certain stages in their growth is very uncertain.

6. With the exception of the late posterior intracranial extensions of hypophysial lesions, every chiasmal lesion which presents symptoms

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requiring surgical relief is accessible by an intracranial approach, although, as I shall subsequently point out, not always operable.

When we view the matter in the light of these observations and when we consider that the transsphenoidal approach is septic, that its exposure is limited to the size of the sellar floor, that it permits no idea of the size and extent of the lesion with which the surgeon has to deal, that it merely allows the removal of portions of a lesion remote from, rather than the portion of the tumor actually causing, the symptoms for which operation is undertaken, that it wholly fails to deal either with intracranial extensions of hypophysial tumors or suprasellar lesions, that its results have been unsatisfactory and merely palliative, can we doubt that, at the present stage of chiasmal surgery, the intracranial approach to chiasmal lesions should have a wider trial? There are good reasons, however, why it should not at the present time be indiscriminately used, for, as the following pages will indicate, its mortality for the time being is high. It has been attended by certain complications, and its results are still none too brilliant.

OPERATION AND COMPLICATIONS

The operation which we have employed is adequately portrayed in the accompanying illustrations drawn by Mr. Brödel and requires little description. An osteoplastic flap is turned down over the fronto-parietal region on the side presenting the greatest visual or other neighborhood symptoms. The flap should be large in order to permit more easily later cerebral dislocation. A dural flap is reflected concentric with the bone flap. Should the brain be under tension, a ventricular or lumbar puncture is performed before the base of the frontal lobe is elevated. The approach to the chiasm is neither a direct frontal nor a temporal, but midway between the two and along the posterior margin of the anterior fossa. It is the shortest approach to the chiasmal region. The posterior part of the base of the frontal lobe is elevated and the chiasm brought into view. The hypophysial lesion, if such it be, will immediately present itself. It has lifted the chiasm and come forward over the anterior margin of the sella turcica between the optic nerves. The extent of the growth and its relations to the internal carotid arteries can readily be determined. The portions of the lesion that appear, be they solid tumor or cyst, are removed, after which the sella turcica can be entered through

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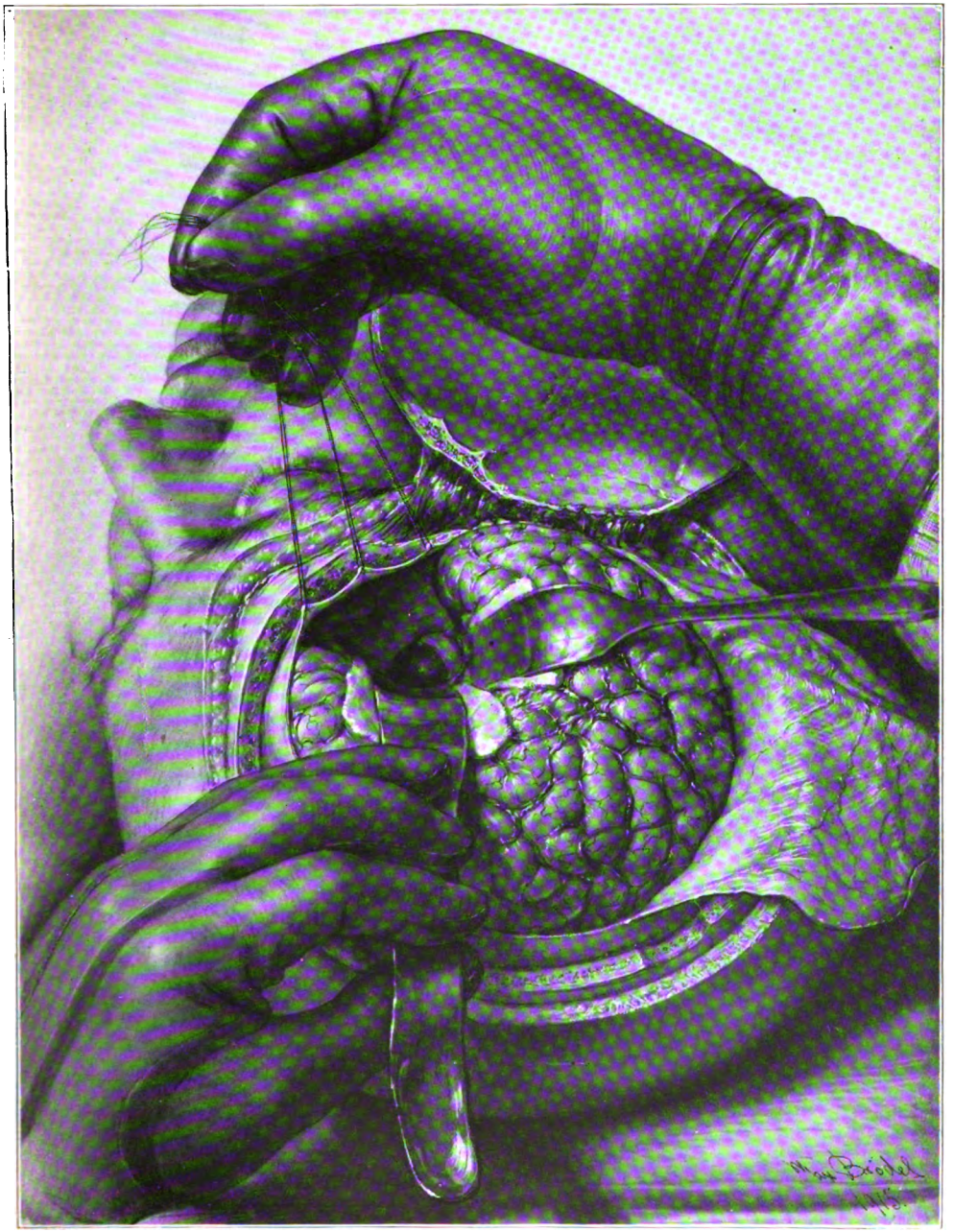

Fig. 2.—Exposure of the chiasmal region. The frontal lobe has been elevated, the temporal lobe displaced posteriorly. The brain is protected by cotton. The right optic nerve has been brought into view and appearing in front of it and between the two optic nerves is a deep red cystic tumor. The anterior cerebral artery is seen crossing the proximal portion of the right optic nerve. (Drawn by Mr. Brödel at operation.)

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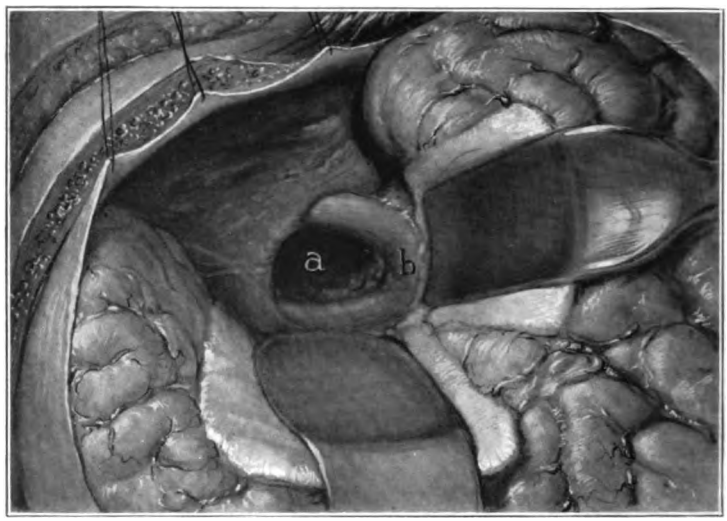

Fig. 3.—Drawing showing the ease with which the sella turcica, *a*, may be entered after removing the anterior extension of a hypophysial tumor; *b*, optic chiasm.

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the space between the uplifted chiasm and the anterior border of the sella. In the presence of suprasellar lesions a different picture presents itself. The optic chiasm is depressed, not elevated as in chiasmal lesions. The part of the lesion that appears is behind the chiasm, yet

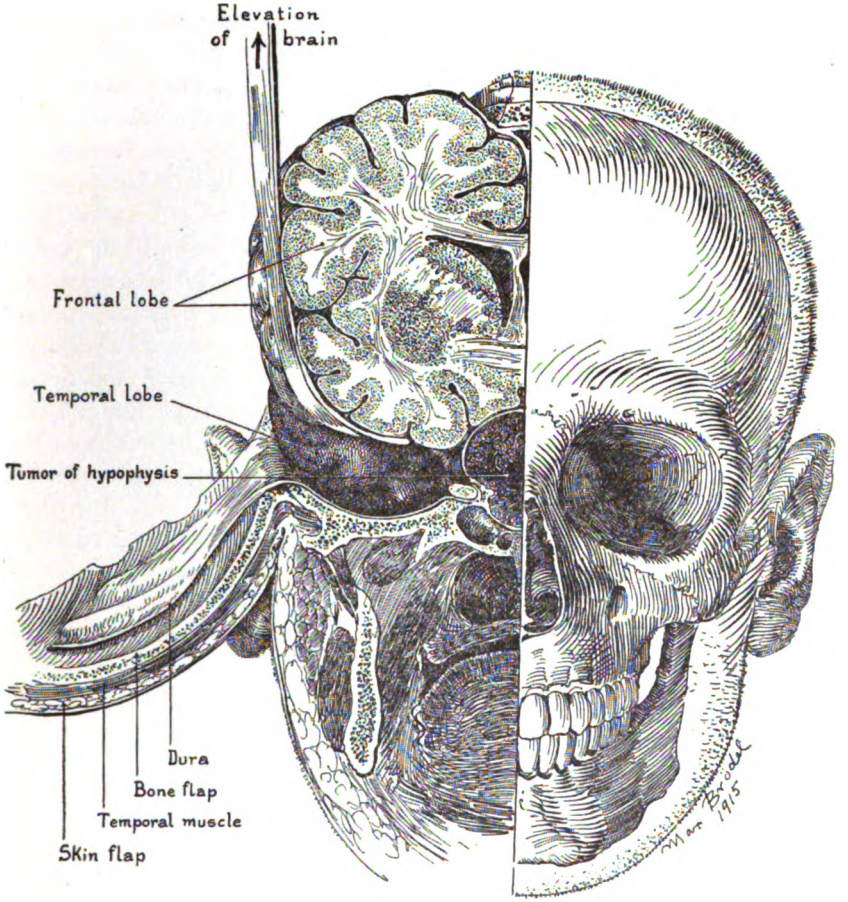

Fig. 4.—Semidiagrammatic sectional view of the approach to the chiasmal region. The approach is a lateral one, along the posterior border of the anterior fossa.

if it is a cyst it can be successfully attacked. In the large lesions, the downward extension may actually be seen occupying the sella turcica.

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This operation has up to the present time been performed largely on patients in the late stages of chiasmal tumors. The lesions have with few exceptions been large. Our attitude toward them has been deliberately radical, and, excepting the solid suprasellar lesions which we have found thus far impossible to remove completely, we have attempted the removal of every lesion which presented itself, regardless of its size. In every case of hypophysial lesion, we have entered the sella turcica and removed partly or wholly its intrasellar portion.

The complications which we have encountered at the time of operation are these: Sufficient elevation of the brain to deal successfully with the lesion has been impossible in the case of solid suprasellar tumors only. In the course of elevation, the cortex has, of course, been compressed, but not lacerated, due to careful protection and the use of broad spatulas. As a result of this elevation the olfactory nerve has been torn out of the cribriform plate on the side of operation in two instances. Unintentional laceration of one optic nerve has occurred in one case during the attempt to remove a large hypophysial tumor. The internal carotid artery infiltrated and surrounded by tumor tissue was once completely torn across flush with its point of entrance into the intracranial chamber. The hemorrhage was successfully controlled, but only after ligation of the internal carotid in the neck. Injury to the anterior cerebral artery occurred in two instances, but in each the vessel was successfully ligated.

The postoperative complications, aside from those due presumably to hypophysial deficiency, have been largely the result of elevation of the brain. Convulsions occurring within forty-eight hours after operation occurred in three cases; twitching of the muscles of the face and hand occurred in three additional cases. Weakness of the face alone or the face and arm occurred in three cases. Speech defects occurred in two cases. These complications in those who recovered from the operation were but temporary and had disappeared usually by the end of the first week. Cerebral edema giving rise to general pressure symptoms occurred in two cases and was the primary cause of death. A sharp temperature reaction, the temperature sometimes rising to from 105 to 106 F., has been common.

Symptoms of disturbed hypophysial function have been present as follows: A stuporous lethargic condition has been present in six cases; excessive thirst in three cases; marked polyuria and polydipsia in four

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cases; excessive hunger in two cases. A few of our deaths, as we shall point out, occurred in patients showing signs of hypophysial deficiency, and it is possible that our extirpations have been too radical.

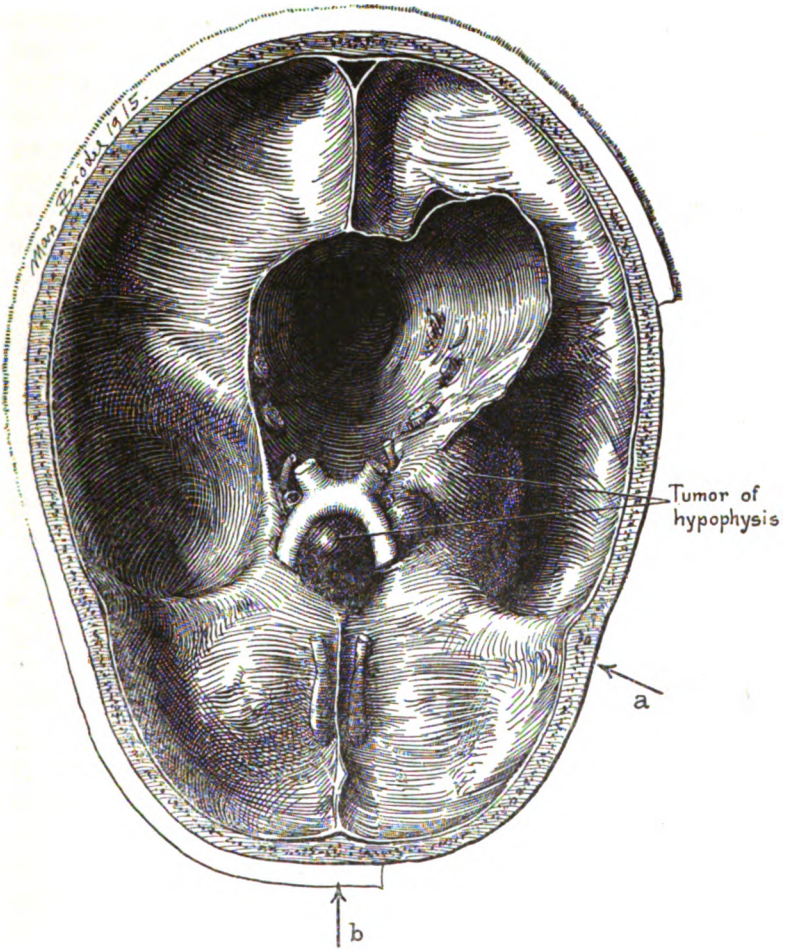

Fig. 5.—Drawing from a necropsy specimen showing the common anterior extension of a hypophysial tumor and also a lateral extradural extension of the growth into the temporal fossa. The approach is in the direction of the arrow at *a*. The lateral extension of the tumor in this case was accessible.

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RESULTS

Six patients, as previously noted, were not treated. They were either the very early cases included in Group 1, stationary acromegalics in whom operation did not seem indicated, or patients that refused operation. Two patients were treated by decompression for the relief of pressure symptoms. Five patients were subjected to a transsphenoidal operation, and all recovered. It is in the cases in which an intracranial operation was performed that we wish especially to study the results. Thirty intracranial operations with partial or complete removal of solid tumors or with evacuation of cysts were carried out on twenty-four patients. In six of these patients, therefore, a second operation was performed from one to three years after the first. The primary mortality was 37 per cent.; the total mortality from additional deaths due to second operations performed from one to three years after the primary operation was 46 per cent. When we examine into the causes of death we find: Eight of the deaths occurred within twelve hours after operation, and in these death must be ascribed directly to the operation. In three of these cases, death was due presumably to shock; in two cases it was preceded by signs of a rapidly on-coming cerebral edema. In three cases, the patients recovered consciousness and for a time were in good condition, with a not unusually rapid pulse and normal respirations. Within a few hours, however, the temperature rapidly rose to from 104 to 107 F., the pulse became rapid, the respirations increased in frequency but later decreased to as low as six per minute, stupor and unconsciousness appeared, and in this condition the patients died. Of the remaining six deaths, one occurred on the fourth day after operation due to a repeatedly forming extradural clot; two patients died suddenly—one thirteen days after operation following straining at stool, the other fourteen days after operation, from pulmonary and cerebral embolism (confirmed at necropsy); two patients died five days after operation with all the signs of hypophysial deficiency, and one patient died forty-six days after operation from internal hydrocephalus unrelieved by operation or by repeated ventricular puncture.

Of the patients who survived the primary operation, six were subjected to a second operation for a recurrence of the symptoms. One (suprasellar cyst) had recovered her vision and was entirely free from symptoms for one and a half years; then died following the

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second evacuation of the cyst. One (hypophysial cyst) was free from symptoms for seven months, then had a recurrence of symptoms and died following the second evacuation of the cyst. One (adenoma of hypophysis) was free from symptoms for one year; then had a recurrence and died with symptoms of hypophysial deficiency following a second extirpation. Two (adenomas of hypophysis) who were free from symptoms for two years and one year, respectively, were subjected to second operations because of recurrence of the symptoms. Both recovered and are still free from symptoms, five years after the primary operation. One (tumor of optic chiasm) who was free from symptoms for four years, developed general pressure symptoms, due presumably to an internal hydrocephalus, and was subjected to a second operation which terminated in a decompression. This patient recovered from the second operation but has recently died. Of the remaining cases, one (suprasellar solid tumor), admitted with marked pressure symptoms for which a decompression was performed six years ago, is living and is absolutely without symptoms five years after a partial extirpation of the growth. One (hypophysial adenoma) is entirely free from symptoms three years after operation. One (hypophysial adenoma), operated on two years ago, is living but from a recent letter is apparently beginning to have a recurrence of the symptoms. One (hypophysial adenoma) died at her home four months after operation. One (suprasellar cyst), operated on four years ago, has not been heard from.

Our total results to date, therefore, in the group of cases in which an intracranial operation was performed, are three patients living and free from symptoms five years after operation, one patient living and free from symptoms three years after operation, and one patient living but with probably a recurrence of symptoms two years after operation. One patient lived quite free from symptoms for four years after operation, then died of internal hydrocephalus, the result of occlusion of the third ventricle. Three patients lived for from one to one and a half years quite free from symptoms, but died as a result of second operations performed for a recurrence of symptoms.

COMMENT

In view of what was attempted and actually done, it would be unfair to compare our mortality with that of the transsphenoidal opera-

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tion. When we review the cases in which an intracranial operation was performed, we find that the large majority were late cases in which, in addition to the local symptoms of chiasmal disease, general pressure symptoms were present. A number of these patients had had transsphenoidal operations performed by other surgeons and came to us for a recurrence of symptoms. In other words, our efforts were directed toward relieving those who were beyond help from the point of view of transsphenoidal operations, and in whom a simple decompression for the relief of pressure symptoms had been heretofore thought to be the only possible means of relief. Viewed from this standpoint our results are not quite so insignificant as would at first appear.

We may thus summarize our experiences in regard to the operability of chiasmal lesions: Chiasmal lesions are quite accessible by an intracranial approach. The cystic tumors whether hypophysial or suprasellar are, however, prone to recur, and we have not as yet been able by an intracranial approach to prevent their recurrence. The solid hypophysial tumors, excepting the rare posterior extensions, may be removed; when large, their removal has been attended by a high mortality, when small by a much lower mortality. The true lesions of the optic chiasm are so few that they need not seriously be considered. Yet they are capable of removal, and in our single case the patient lived for four years quite free from symptoms. The suprasellar solid tumors have thus far in our experience been impossible to remove completely; yet in one instance by a partial removal, we cured an internal hydrocephalus causing marked pressure symptoms, and the patient is still living and free from symptoms five years after operation.

As to the choice of operative procedures in patients who present signs of chiasmal lesion, we would suggest that both the transsphenoidal operation and an intracranial operation such as we have used have a field of usefulness. In the early cases which present sellar headaches and evidences of secretory derangement but without visual disturbances or destruction of the clinoid processes of the sella turcica, a transsphenoidal operation may well meet the requirements. A certain number of these patients may remain well for long periods; a fairly large number will sooner or later develop an intracranial extension of the growth, causing visual disturbances and destruction of the clinoid processes. Just as soon as these signs appear, the transsphenoidal approach

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will fail to deal adequately with the lesion; and rather than repeat this procedure it would appear wise to resort to an intracranial operation. For all other chiasmal lesions which at the time first observed are associated with visual disturbances and alterations in the shape and size of the sella turcica, the intracranial operation is the operation of choice; for in these we know that an intracranial tumor is present. It is true that our mortality following this operation is at present high; but we have reason to believe that if this operation is performed before the intracranial growths are too large, the mortality will be greatly lowered.

ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. ADSON AND HEUER

Dr. George M. Dorrance, Philadelphia: In subacute and chronic brain abscess, the dura should not be opened, but the abscess should be located with a fine trocar by puncture through the dura. If the abscess is located, the material should be aspirated out and a tube passed through the trocar and sutured in place. Twenty-four or forty-eight hours later, a larger trocar is introduced over the tube and gradually the channel is enlarged so that a speculum may be introduced, and by reflected light the channel is inspected. The mortality from meningitis was greatly diminished by the dura becoming adherent. The complication of hernia cerebri did not develop.

Dr. A. W. Adson, Rochester, Minn.: Dr. Heuer emphasized particularly the advantages and disadvantages of the intradural approach to the pituitary gland. It was he who first interested me in employing this technic. The intradural approach has certain distinct advantages in that the surgeon is able to expose the pituitary gland, optic peduncles and commissure, and to remove suprasellar and intrasellar neoplasms under aseptic conditions. The transphenoidal approach is indicated, however, in selected cases, that is, patients with pain and enlargement of the sella without optic symptoms. and patients in whom the growth has extensively eroded the sella and grown posteriorly downward. The mortality in these cases has been rather high, but I believe it can be reduced if the patient is studied. In a group of twenty-six operative cases there were six deaths and, in studying the records, we found that all of these patients were persons who weighed about two hundred pounds, had a low blood pressure, a lowered metabolic rate, and presented symptoms of hypopituitarism. It is very evident that patients with marked hypopituitarism are poor operative risks, and that if surgery is contemplated, preliminary treatment must be administered.

Dr. George J. Heuer, Baltimore: I make rather a large flap. It comes far forward. The approach is not a direct frontal, nor is it a temporal. but lies midway between the two. The intrasellar portions of tumors can be approached readily. One of the criticisms of the intracranial method is that it does not allow one to deal adequately with the intrasellar portion of the tumor.

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HEMANGIOMA AND LYMPHANGIOMA

THEIR RESPONSE TO THE INJECTION OF BOILING WATER

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A hemangioma is a tumor composed of an abnormal formation of blood vessels produced from a matrix of angioblasts. A lymphangioma is a tumor composed of an abnormal formation of lymph vessels also produced from a matrix of angioblasts. These tumors are congenital in their origin and clinically are considered nonmalignant, although their histologic formation closely resembles certain types of malignancy.

Angioma and lymphangioma are closely allied to endothelioma, the cellular elements lining the walls of the vascular spaces possessing the shape and arrangements of the mother soil. In differentiating a vascular tumor of an angiomatous nature from a varicose vein or an aneurysm, the character of the formation must be taken into consideration. For the growth of a normal blood vessel the angioblasts furnish the essential tissue elements. When such a blood vessel has reached its requisite normal size, the process becomes stationary.

In the development of an angioma there is, however, no limitation, and the function of the angioblasts and their product of tissue proliferation results in the atypical blood vessels, which constitute the essential tumor tissue of a hemangioma.

The growth of an angioma is governed by the formation of new blood spaces which enter into communication with the older blood spaces. When the

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tissue proliferation is a rapid one, the tumor grows correspondingly in size. In a varicose vessel or an aneurysm such a process of proliferation does not take place, the size and form of the tumor being the result of a weakening of the wall, the result of disease. The differentiation of a lymphangioma from elephantiasis arabum is borne out on similar lines. New vessels are formed by angioblasts in the walls of preexisting lymph spaces by a process of budding. These new lymphatic channels coalesce and communicate with the older lymph channels, the process extending into places in which, in normal conditions, no lymphatics are found, thus producing the characteristic phase of a lymphangioma. In elephantiasis arabum, the lymphatic enlargement is a dilatation of a diseased preexisting vessel.

On an anatomic basis, hemangiomas and lymphangiomas can be classified into three species: the capillary variety, the cavernous variety, the plexiform variety of the angiomas and the lymphatic cystic variety of lymphangiomas.

The capillary variety is the incipient form of vascular tumor, and as a rule the tumor tissue does not extend beyond the subcutaneous cellular tissue. This form is of little clinical significance.

The cavernous variety has its seat in the deep connective tissue. Its formation presents a distinct tumor. This form is of much clinical importance.

The third variety of hemangiomas, the plexiform species, is very rare. It has also been known as "aneurysm by anastomosis" or "cirsoid aneurysm." Such angiomas may consist of arteries only, or of veins, or of arteries and veins in equal proportion. When the arterial element predominates, a marked tortuosity of the vessels is apparent.

The cystic variety of lymphangiomas differs from the cavernous in so far that the individual separate spaces arising from new and dilated lymph channels possess forms which correspond with their

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origin. They are more or less globular in shape and more prone to progressive growth than the cavernous.

Hemangiomas and lymphangiomas have many fundamental points of structure in common, and a differentiation between them should present no difficulties. The content of the former is blood, that of the latter lymph. A hemangioma has a bluish discoloration, and the tumor can be usually emptied of its content by gentle pressure.

A lymphangioma is generally colorless. Occasionally the walls of the lymphatic cyst will harbor blood vessels which will impart to it a blue or pink discoloration. The contents of a lymphangioma can not be expressed; the tumor, however, on account of its firmness and elasticity, will permit of a certain degree of compression.

Angiomas are met with more frequently than lymphangiomas, in my experience in a ratio of 15 of the former to 1 of the latter.

METHOD OF TREATMENT WITH BOILING WATER

With this preamble concluded, let us consider the treatment of these vascular tumors with the injection of boiling water. These neoplasms may develop in any part of the body; the face, however, seems to be a preferable region for the angiomas. It is therefore significant that any treatment instituted should invite the least amount of disfigurement through scar formation.

Of all surgical measures, the ideal treatment is excision. This is the method of election, provided the tumor is favorably situated and the operation can be undertaken without the danger of great hemorrhage or the loss of important structures.

The excision of a vascular tumor in the face demands the most serious contemplation, and should be undertaken only when other methods of a less radical

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nature, but far more pleasing in their outcome, have been found unsuited to the particular neoplasm. Of the less radical methods, the injection of boiling water into the angioma is deserving of the most serious consideration.

This measure was originated by Dr. John A. Wyeth. It possesses a distinct advantage over all other coagulating methods, especially the irritating injections of chemical substances, which possess little or no merit, and are often harmful. The object of the treatment is to destroy the growth with all its constituent elements by an interstitial action. The action of boiling water injected into a hemangioma or a lymphangioma will by coagulation convert its contents into a compact mass, causing a vascular blockade by aseptic thrombosis. The subsequent course is a degenerative tissue metamorphosis, granular or fatty in nature, resulting in the gradual obliteration (partial or complete) of the tumor.

The injection of boiling water into a hemangioma has been a most encouraging procedure, the tumor invariably disappearing in from four weeks to four months, the time for obliteration being governed by the size and location of the tumor. About 200 hemangiomas have been subjected by me to this method of treatment, and the results have been very satisfactory, more so than they could have been by the excision method; in fact, some of these tumors were hopelessly inoperable.

When the results of the lymphangiomas injected with boiling water are reviewed, they contrast negatively with the splendid results obtained in hemangiomas.

It was noted that the injection of boiling water into a hemangioma was followed by very mild systemic disturbances, whereas the reaction in a lymphangioma was often violent and lasted for a period of from three to five days. In the series of 200 cases of heman-

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gioma, five became infected. These infected cases responded promptly to aseptic wound treatment.

In a series of eight lymphangiomas injected with boiling water, two became infected. The infections were undoubtedly of a hematogenous nature, in the one case resulting from a sore throat and in the other from an ulcerated tooth. These patients were seriously sick, the severest systemic disturbances lasting from ten to fourteen days. The parts involved (in one case the hand, in the other the foot) presented the clinical characteristics of a phlegmonous inflammation. There were present chills, a temperature of 104-105, delirium and vomiting. The inflammatory condition did not result in suppuration in either case. Both patients recovered after a protracted convalescence.

The predisposition to infection of an injected lymphangioma must be ascribed to the low resisting power of the coagulated lymph. With an injected hemangioma such a predisposition does not seem to exist, presumably because, blood being a tissue of high resisting power, bacterial invasion becomes more difficult. The response from the injection of boiling water in the eight cases of lymphangioma, although not so encouraging as the results achieved in the angiomata, was satisfactory.

It may be said that in two cases the tumor has entirely disappeared. In the remaining six cases the tumor was reduced to about two-thirds its normal size. A second or third hot water injection given in four instances had little influence on any further shrinkage of the tumor. In those cases in which the lymphangioma involved the hand or the foot, together with some of the fingers and toes, the injection caused a marked decrease in the size of the hand or foot. The enlarged fingers or toes, however, were affected only to a small degree.

Although the response coming from an injected lymphangioma does not give the encouragement an injected hemangioma does, the measure of injecting a

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lymphangioma with boiling water is a more valuable asset, especially in those cases in which an operative procedure is contraindicated and an intervention becomes imperative.

ABSTRACT OF DISCUSSION

DR. RUDOLPH MATAS, New Orleans: A method which I have found most satisfactory in the treatment of lymphangiomas consists essentially in infiltrating the tumor with a solution of epinephrin and procain, until the mass becomes hard and completely bleached by the ischemic effect of the solution. The little, thin pellicle of nevoid skin, or port wine spot, that overlies the deeper lymphoid mass, is shaved off or excised sufficiently to expose the bed of lymph tissue which appears as a whitish semigelatinous material. This tissue is wiped, or scrubbed, off with a dry gauze sponge until none of it remains. The result is a subcutaneous cavity with a small crater-like opening which closes quickly with a minimum of scar formation. The operation is, as a rule, practically bloodless; no individual ligatures are required even where very large tumors are attached. The bleaching (ischemic) effect of the epinephrin solution differentiates the abnormal from the normal tissue, and the soft, mushy and gelatinoid consistence of the lymphoid and angiomatous tissue permits its removal by the scrubbing method with the least damage to the normal tissues. This procedure is especially applicable to babies and young children. The solution should not contain more than from 5 to 10 minims of the epinephrin solution (1:1,000) to 1 ounce of a 0.5 per cent. procain or apothesine solution. The dense massive infiltration of the tumor with the epinephrin solution being quite sufficient to obtain analgesia, so that, as a rule, no general anesthetic is required. In the treatment of nevi, or all pure angiomatous growths, especially about the face or conspicuous parts of the body, radium is the preferred agent. It is especially effective in infants and children and accomplishes the most permanent results in the safest, most esthetic and painless fashion. It must be remembered that the tissues do not react to radium invariably, in the same way. In adults, the resistance of certain nevi to its action is sometimes surprising and disappointing. But in infants and children, in whom the treatment is most indicated, its effects are almost infallible and marvelous. There is, of course, no single agent or method of treatment that is applicable to all the varieties of angioma or lymphangioma, but Dr. Reder has shown what excellent results can be obtained by one method, in a large group of cases, when this is handled skillfully.

DR. VILRAY P. BLAIR, St. Louis: In dealing with lymphangiomas I feel that we have been very much influenced by

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Butlin's caution that a partial removal is liable to result in a malignant degeneration. A complete review of the literature to date has failed to show a single instance of malignant degeneration after the partial removal or irritation of these tumors.

DR. FRANCIS REDER, St. Louis: The splendid results achieved with the hot water injection in hemangioma are somewhat negatived by the results obtained in lymphangioma. Fortunately, these tumors are far less often encountered than hemangioma. I encountered fifteen hemangiomas to one lymphangioma. Of the results in hemangiomata I can speak convincingly, having had more than 200 successful cases.

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SQUAMOUS CELL CARCINOMA OF THE KIDNEY

REPORT OF A CASE OCCURRING IN A HORSESHOE KIDNEY COMPLICATED BY A CALCULOUS PYONEPHROSIS

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Primary cancer of the kidney is not of frequent occurrence. This is particularly true if we exclude hypernephroma, which in the literature of the past has frequently been described as a carcinoma of renal origin, but which most authorities now believe to be derived from suprarenal rests as first suggested by Grawitz. Accepting this theory regarding the origin of hypernephromas as correct, we may state that a primary cancer originating in kidney tissue is derived from the epithelium of the renal tubules.

The occurrence of a squamous cell carcinoma in the kidney is excessively rare, and it becomes a subject not only of interest but of considerable practical value to trace its origin and to study the etiologic factors which lead to its production. Kundrat[1] described the condition in 1891. A perusal of the literature leaves no doubt in one's mind that such tumors arise from the transitional epithelium of the renal pelvis. We may accept the classification of Graupner,[2] who, in studying the histogenesis of primary renal cancers, divided them into two groups: (1) infiltration carcinoma, and (2) adenocarcinoma. The former are derived from the renal pelvis primarily, and the latter from the renal tubules.

1. Kundrat: Wien. klin. Wchnschr. 4: 949, 1891.
2. Graupner, R.: Zur Histogenesis des primären Nierencarcinoma, Beitr. z. path. Anat. u. z. allg. Path. (Ziegler's) 24: 399, 1898.

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The case herewith recorded is of further interest because it was associated with a calculous pyelitis. The presence of stone in the kidney plays an important rôle in the production of cancer; thus, in the Mayo Clinic not less than 50 per cent. of all cases of epithelial cancer of the kidney which have come to operation were superimposed on extensive renal calculous formation. In addition, my patient exhibited the unusual anomaly of a horseshoe kidney, a condition which, according to Adami,[3] is present in 0.4 per cent. of necropsies.

REPORT OF CASE

Examination.—Mrs. F. J. S., aged 58, came to me in January, 1919, complaining of pain in the back and right side. She stated that since early childhood, or as long as she could remember, she had had some distress in that region. She had an abdominal tumor visible to the eye. Its most prominent portion was behind the right rectus muscle, below and to the right of the navel. It could be palpated through to the loin; there was dulness in the flank and resonance on percussion over the outer portion of the tumor. There was also a definite projection of the tumor across the middle line to the left side, extending fully 7 cm. to the left of the linea alba. Percussion over this part of the tumor elicited resonance. An area of resonance existed above, between the tumor and the liver. One could detect fluctuation through the tumor from the anterior portion back to the loin. The patient had some slight evening elevation of temperature, and she had lost 20 pounds in weight.

My colleague, Dr. W. W. Jones, made a cystoscopic examination and found the bladder healthy in appearance. Urine flowed freely from the left ureter and proved to be normal on analysis. The phenolsulphonephthalein test came through in six minutes. It was impossible to pass the catheter into the right ureter more than half an inch. There was absolutely no flow of urine from the right ureteral orifice. The roentgenogram showed a stone about the size of a filbert in the center of the tumor behind the outer part of the right rectus muscle. A second shadow of a stone, somewhat larger, was seen in the middle line or slightly to the left of the middle line.

Operation and Results.—Jan. 13, 1919, an oblique incision was made over the anterior surface of the tumor. When the peritoneum was opened, the tumor was found to be retroperitoneal and to extend across the spinal column into the

3. Adami, J. G., and Nicholls, A. G.: The Principles of Pathology, Ed. 2, Philadelphia, Lea and Febiger 2: 728, 1909.

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left lumbar region. Its main bulk, however, was to the right of the spine, where it lay in the right lumbar space as an elastic mass obviously containing fluid. A very careful inspection was then made of the entire tumor. It consisted of two portions, one occupying each lumbar region and connected by a broad thick bridge of tissue. The bridge was so thick and broad that there was little differentiation between it and the two masses which it connected. The left lumbar region was carefully explored to make certain that there was no further evidence of a left kidney behind. It became obvious that we were dealing with a horseshoe kidney. I then incised the posterior parietal peritoneum over the face of the cyst to the right of the ascending colon, after which I marsupialized this by uniting with suture the margins of the incision in the posterior peritoneum to that in the anterior peritoneum. Thus the general peritoneal cavity was completely closed off from the field of operation. I cut through a further covering of the cyst consisting of the fatty capsule which was about 2 mm. in thickness. I inserted a large trocar and drew off yellow purulent looking material which was watery in consistency. I then incised the cyst. I found a mulberry calculus about the size of a filbert lying free in the cyst cavity. I explored the interior of the cyst with my finger and discovered another stone projecting into the cyst cavity from a solid part of the tumor which lay anterior to the spine. This was fixed in position. While attempting to mobilize this with my finger I fractured a piece from a portion which lay still deeper and which I could not dislodge. The patient was a poor operative risk, and I desisted from any further extensive operative interference. I dissected out a considerable portion of the cyst wall, including a thickened band of tissue which lay across it obliquely. The remaining portion of the cyst wall was uniformly about 3 mm. in thickness. I overcast the cut edge of the cyst wall with catgut for hemostatic purposes, and inserted a drainage tube before closing the wound. During the operation I found on the outer surface of part of the cyst wall an area about 2 cm. in diameter and raised from the surrounding surface for about 3 mm. This was yellowish gray, and possessed a tubercular surface. During the operation, 40 ounces of physiologic sodium chlorid solution were administered interstitially.

The fluid content of the cyst was analyzed by Professor Hunter, who reported: "The fluid had a specific gravity of 1.010 and a faintly alkaline reaction. It contained traces of urea and other urinary constituents, but its chief soluble component was protein. The total quantity of this present was 1.75 per cent. It was partly nucleoprotein, but chiefly coagulable protein (albumin)."

Subsequent to the operation, drainage was maintained, and after the lapse of two months the patient's general condition had improved, but there was still a considerable amount of

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discharge and some absorption, as indicated by an evening rise of temperature to 100 or 101 F. A roentgenogram taken at this stage showed a shadow cast by stones near the middle line of the body, but in consequence of the contraction of the pyonephritic sac toward the opening in the right abdominal parietes to which it had been sutured, the shadow was drawn well to the right of the middle line and therefore appeared to be quite accessible to the finger introduced into the sinus opening, thus making it possible to remove it with safety by a comparatively slight operation. Accordingly, March 20, under gas anesthesia, I enlarged the drainage opening sufficiently to admit two fingers. I located the stones and by scratching through the kidney substance surrounding them, using the bare ungloved finger for the purpose, I succeeded in enucleating from its bed a calculus the size of a large walnut. It was surrounded by many small calculi varying in size from a grain of rice to a small pea. These were removed along with a considerable amount of gritty material, which was taken out by curetting with a scoop, followed by gauze on forceps. Presumably, the stones lay in the pelvis of the right kidney.

On the posterior wall of the cavity, adjoining the pocket that had contained the stones, I detected a somewhat prominent mass of tissue which I took to be kidney substance. I attempted the removal of a portion of this tissue in order that I might determine, by microscopic section, the nature of the condition present. I enucleated a piece about the size of a walnut. This was preserved for future examination. Hemorrhage was slight and was easily controlled. I closed the wound, still maintaining drainage as before. There was no evidence of metastases.

At the time of the first operation, a guinea-pig was inoculated from the pus contained in the cyst. The pig was killed eight weeks subsequently, but was found negative for tubercle bacilli.

The sinus continued to discharge, but the patient's general nutrition was maintained for about five months after the operation, when she began to fail. Toward the latter part of her illness, she developed a fecal fistula, while a tumor growth of a very hard consistency developed. She died eight months subsequent to her first operation. It was impossible to obtain a necropsy.

Microscopic Examination.—The tissue removed at the second operation proved to be a squamous cell carcinoma. The kidney substance in this section was infiltrated and almost destroyed by epithelial cells, which showed marked pearl formation (hornification); several areas showed epithelial cells growing in the dilated lumen of the tubules surrounding the epithelial cell nests. A marked fibrosis had occurred which replaced most of the kidney substance. Dotted through the section were dilated glomeruli showing

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atrophic changes, and around several of these glomeruli there was a round cell and plasma cell infiltration, as shown in the accompanying photomicrographs. The condition was one with which we had hitherto been unfamiliar.

ORIGIN OF THE DISEASE

We may assume at the outset that squamous cell cancer of the kidney has its origin in the pelvis or calices of the kidney. We can better understand the validity of this assumption by a study of the conditions antecedent to its production.

The normal histologic structure of the mucous membrane of the renal calices, pelvis and ureter is a transitional epithelium, of a character similar to that found in the bladder. It is therefore not surprising that the histologic structure of new growths originating from the mucous membrane of these urinary passages has very similar characteristics. A villous papilloma is a benign growth of frequent occurrence in the bladder, and has also been found as a primary growth in the ureter, pelvis and calices. That a villous growth may develop into a malignant tumor was demonstrated by Virchow. Villous tumors of the ureters have been described by Poll,[4] de Josselin de Jong,[5] Stoerk,[6] Kohlhardt,[7] and others. The epithelium in these cases may resemble that of the normal mucous membrane, or may vary within wide limits, being cylindric, cubical, spindle shaped or polygonal; not infrequently different types of cell are present in the same tumor. On the other hand, a malignant squamous cell cancer has been found in the urinary passages without villous formation. A notable example of this was placed on record by Rundle.[8] In his case, the lower 3 inches of the right ureter were involved in a large growth which extended

4. Poll, B.: Ein Fall von multipler Zottengeschwulst im Ureter und Nierenbecken, Beitr. z. klin. Chir. (Brun's) **23**: 822, 1899.
5. De Josselin de Jong: Ein Fall von Carcinoma papillare des Nierenbeckens, Beitr. z. path. Anat. u. z. allg. Path. (Ziegler's) **35**: 205, 1904.
6. Stoerk, Oskar: Ein Fall von Papillomatose des Nierenbeckens, des Ureters und der Blase, Beitr. z. path. Anat. u. z. allg. Path. (Ziegler's) **26**: 368, 1899.
7. Kohlhardt, H.: Ueber eine Zottengeschwulst des Nierenbeckens und des Ureters, Virchows Arch. f. path. Anat. **148**: 565, 1897.
8. Rundle, H.: Epithelioma of the Ureter Causing Hydronephrosis, Tr. Path. Soc. London **47**: 128, 1896.

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down to within 1 inch of the bladder; a small polypoid growth the size of a pea protruded into the bladder through the ureteral orifice. The interior of the ureter, almost up to the renal pelvis, contained numerous small, isolated nodules. These multiple tumors presented the histologic picture of a squamous cell cancer. Wilson [9] of the Mayo Clinic describes a similar squamous cell epithelioma of the renal pelvis, resembling histologically a cancer of the hip. Hektoen [10] records a case of primary cancer of the lower end of the ureter containing cells of different types, oval, spindle and club shaped; he states that, in places, masses of cells showed degenerative changes which might in some instances be mistaken for epithelial pearls.

The occurrence of new growth in the calices and the pelvis of the kidney is associated with chronic inflammatory changes due to some form of irritant. The frequent association of stone with this condition is noteworthy. Calculi were present in the case here recorded. Hartman [11] describes a case of primary cancer of the renal pelvis associated with calculous pyelitis. Kischensky [12] found the ureter blocked with calcareous concretions, and Scheel,[13] although he did not find a stone, suspected one had been present at an earlier date from the previous history of pain, etc. Wilson [9] mentions two cases superimposed on extensive renal calculous formation. In most instances, the subepithelial connective tissue exhibited a round cell inflammatory infiltration (Scheel,[13] Kischansky,[12] Stoerk,[6] and others). The most noticeable feature in this regard, however, is the associated proliferation of

9. Wilson, L. B.: The Embryogenetic Relationships of Tumors of the Kidney, Suprarenal and Testicle, Collected Papers of the Mayo Clinic, 1912, p. 304.

10. Hektoen, Ludvig: Observations on Gumma of the Hypophysis and Primary Carcinoma of the Ureter, J. A. M. A. **26**: 1115 (June 6) 1896.

11. Quoted by Kischensky (Footnote 12).

12. Kischensky, D. P.: Primärer Plattenepithelkrebs der Nierenkelche und Metaplasie des Epithels der Nierenkelche, des Nierenbeckens und des Ureters, Beitr. z. path. Anat. u. z. allg. Path. (Ziegler's) **30**: 348, 1901.

13. Scheel, P. F.: Ueber ein eigenartiges Kankroid der Niere, Virchows Arch. f. path. Anat. **201**: 311, 1910.

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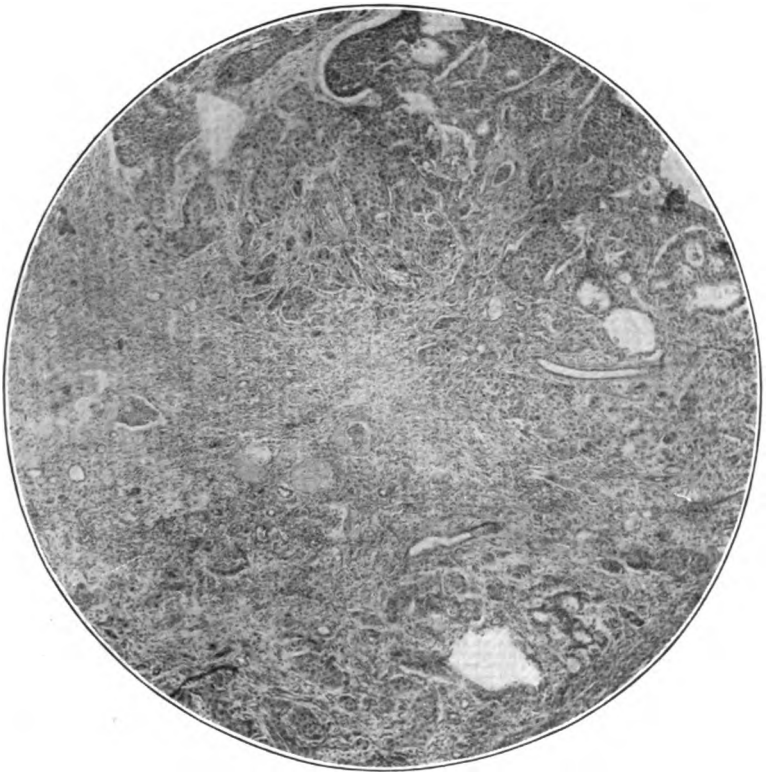

Fig. 1.—Squamous cell cancer of the kidney: tumor growth at the margin, and a number of sclerosed and partially sclerosed glomeruli; also tubules invaded by the growth; × 50.

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Fig. 2.—Squamous cell cancer of the kidney: tumor growth and renal tubules; × 200.

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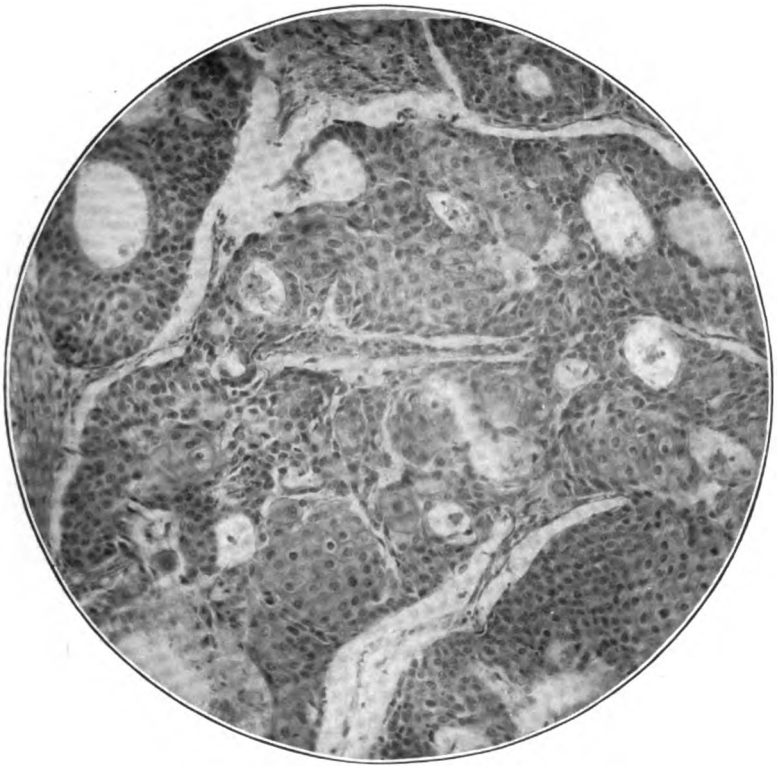

Fig. 3.—Squamous cell cancer of the kidney: masses of squamous epithelial cells with pearl formation; also renal tubules; × 130.

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Fig. 4.—Squamous cell cancer of the kidney: a number of mitotic figures (monaster); a number of these are found throughout the tumor showing a fairly rapid growth; × 2,000.

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the transitional epithelium of the ureter, pelvis and calices. This was present to an exaggerated degree in Kischensky's case in which, associated with a squamous cell cancer of the calices of the kidney, there were extensive metaplastic changes in the epithelium of the calices, pelvis and ureter. Thus the wall of the ureter presented, under the microscope, a cutis-like formation with extensive cornification of the superficial layers of cells; the deeper layers were more or less cylindric, while the superficial layers were composed of pavement epithelium, exhibiting cornification on the surface. Some of the cells of the deeper layers exhibited bridges, giving the appearance of prickle cells. In the renal pelvis, there was a calcareous incrustation, over which were found pus cells. Rokitansky [11] describes a condition in the renal pelvis in which from the proliferated epithelium there is much desquamation; these desquamated cells are massed together with much detritus and cholesterin crystals, producing the condition which he describes as cholesteatoma. Baselin [14] records a similar condition, which he calls cholesteatomatous desquamation of the cells of the pelvis associated with primary tuberculosis of the kidney.

The epidermization of the transitional epithelium in the ureter, pelvis and calices may thus proceed with a high degree of cell proliferation, in which the superficial layers are hornified. Halle [11] has suggested for this condition the name leucoplasie urinaire, resembling the so-called leukoplasia of the mouth cavity, which is not infrequently recognized as a precancerous condition.

The fact that squamous cell cancer of the kidney is due to the invasion of the kidney substance by a growth which is primary in the pelvis and calices is attested by the findings in certain of the reported cases. Scheel,[13]

14. Baselin, Otto: Cholesteatomartige Desquamation im Nierenbecken bei primärer Tuberkulose derselben Niere, Virchows Arch. f. path. Anat. 99: 289, 1885.

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for example, records a case of a tumor which presented the characters of a squamous cell epithelioma of the kidney substance, showing pearls and hornification. This was in direct continuity with a tumor of the kidney pelvis in which the cells were mostly cylindric in type, and which developed as a villous growth; these cells were supported on a vascular connective tissue which was infiltrated by a growth of squamous cells with pearl formation and basal cells. Between the squamous cell growth of the kidney substance and the tumor of the pelvis there was almost everywhere a sharply defined barrier of connective tissue, but in certain places this barrier was broken down and the two growths become continuous. Scheel considers the two growths of common origin, and concludes that the original tumor was an epithelioma arising probably in connection with the kidney calices and developing, on the one hand, as a cylindric cell papilloma invading the kidney, pelvis, and on the other hand, as a squamous cell cancer of the kidney substance. Hilderbrandt [15] describes a large growth which in its pelvic portions were papilliary and in the renal substance scirrhous (Ewing[16]). Cylindric cell papillomas in the pelvis and ureters have been described by several writers. Rundle's case, already quoted, gives us an example of a squamous cell growth accurring in the ureter without villous formation.

Busse [17] describes a case of squamous cell cancer of the bladder associated with papillomatous growths in the ureter.

It would appear, therefore, that squamous cell cancer of the kidney substance is derived from a primary growth in the calices or pelvis; this in turn may be accompanied, as in Kischensky's case, with extensive

15. Hildebrandt: Arch. f. klin. Chir. (Langenbeck's), quoted by Ewing (Footnote 16).
16. Ewing, James: Neoplastic Diseases, Philadelphia, W. B. Saunders Company, 1919, p. 743.
17. Busse, Otto: Geschwulstbildung in den grossen Harnwegen, Virchows Arch. f. path. Anat. 164: 119, 1901.

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metaplasia and epidermization of the epithelium of the calices, pelvis and ureters.

These squamous cell carcinomas of the kidney or pelvis are accompanied by extensive metastases. In the case recorded in this paper it was impossible to establish the existence or nonexistence of these, as it was impossible to obtain necropsy. In Scheel's [13] case, metastases occurred in the liver, the lung and the hilum glands. In Kischensky's [12] case they were present in the liver, the hilum glands and in the lower end of the femur. In all instances the metastatic growth exhibited the characteristic structure of squamous cell cancer.

CONCLUSIONS

As the result of a critical study of recorded cases, we may arrive at the conclusion that the usual form of renal tumor described as squamous cell cancer is a growth having its origin in the transitional epithelium of the calices and renal pelvis with subsequent invasion, by direct extension, of the kidney substance. Its development is closely associated with the production of villous growths which, at first benign, may develop malignancy. In certain instances also there may be extensive metaplasia of the transitional epithelium of the calices, pelvis and ureter. The entire process is in all probability preceded by chronic inflammatory changes produced by some irritant, such as the presence of stone.

100 College Street.

ABSTRACT OF DISCUSSION

DR. ARTHUR DEAN BEVAN, Chicago: Twenty-five years ago we did not have the same conception of kidney tumors that we have today. I had an opportunity to work in Birch-Hirschfeld's pathologic institute in Leipzig when he was doing a great deal of work on hypernephroma. He coined the word. A large series of cases reported by Israel then were mostly considered carcinoma, then sarcoma; but after the work of Birch-Hirschfeld, Israel studied his specimens again, and instead of reporting carcinoma as a common type of malignant tumor of the kidney, he labeled these cases

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hypernephroma. For a number of years we have accepted the view that hypernephroma is a common type of malignant tumor of the kidney. Of more than one hundred cases of malignant tumors of the kidneys in my own service, hypernephromas numbered more than 80 per cent. of the total cases; sarcoma, occurring early in life, formed the second group. Carcinomas are exceedingly rare. I have had only four cases in which the microscope showed carcinoma. The type of carcinoma has been for the most part the same as is found in the bladder and, occasionally, in the ureter. It is not at all surprising that under certain conditions metaplasia takes place. Years ago it was pointed out that metaplasia occurred in the epithelium of the gallbladder and that squamous carcinoma developed. Today that is a well-recognized fact. Another interesting fact is the development of leukoplakia in the bladder, ureter and pelvis of the kidney, especially in the presence of chronic irritation. A number of cases of epithelioma of the body of the uterus from chronic irritation from the stem pessary have been reported.

Dr. William J. Mayo, Rochester, Minn.: We can get a better idea of the solid tumors of the kidney by going back to the embryology of the organ. I agree with Cushny that the kidney is essentially a filter. That part of the kidney which rises from the diverticula of the wolffian duct and is lined originally by pavement epithelium forms the part of the kidney that collects the urine, that is, the pelvis, the calices and the straight tubules, and from these tissues originate the transitional forms of carcinoma Dr. Prim- described. I agree with Doctor Bevan as to the great frequency of the so-called hypernephroma. These tumors are mesotheliomas derived from the filter part of the kidney as shown by Wilson, and not hypernephromas. Merely because it was noted that their structures were arranged in parallel columns and were yellow, they were believed to have their origin in suprarenal rests. The little yellowish bodies believed to be suprarenal rests are found in the capsule, while the tumors themselves are found in the substance of the kidney. The case Doctor Primrose reported is exceedingly interesting because the tumor occurred in a horseshoe kidney which would add greatly to the difficulties of removal. We have observed a small number of such tumors, but none in horseshoe kidneys. The operations have been exceedingly difficult. In some of our cases, in which the right kidney was involved, the retroperitoneal part of the duodenum was injured in an attempt to remove it. In one case, the injury was due to rat toothed forceps hastily applied to check hemorrhage; necrosis and leakage followed and in two weeks the patient lost almost all the superficial epithelium of the body. The patient died. In the second case, after the fistula had occurred, I made an

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incision in front, dissected the duodenum up, closed the fistula, and tucked the omentum around it; this patient recovered. I have since seen two similar cases and have known of a number of other cases of this type of malignant disease involving the pelvis of the kidney in which the accident happened in attempts to perform nephrectomy, and, except in the cases in which a second operation was made in front and the fistula closed by suture, the patients died. The vena cava may be injured in the removal of these tumors on the right side. This accident is not necessarily a fatal one. It is surprising how readily the vena cava may be mended; it can be picked up between the fingers and can be sutured with catgut, care being taken that the endothelium on the inside of the vessel is brought into contact. In exactly the opposite of the method of suturing the intestine, big notches involving nearly a half of the lumen may be left without harm.

Dr. John J. Gilbride, Philadelphia: There may be considerable difficulty in making a diagnosis because of the absence or almost complete absence of local signs or symptoms in the early stages of the disease, even after one has been able to palpate a definite mass in cases of hypernephroma or sarcoma of the kidney. There may be an absence of blood or other changes in the urine until the case is so far advanced that the patient practically dies of suppression of urine and the symptoms are those of uremic coma. In malignant disease of the kidney one frequently finds a slight elevation of temperature, perhaps 99 or 99.5 or a little higher, together with an increase in the pulse rate —up to 80, 90 or even 100—suggesting the presence of an infection. Even after extensive study and careful roentgen-ray examination I have seen cases of malignant disease of the kidney in which a diagnosis of infection had been made.

Dr. Albert J. Ochsner, Chicago: I wish to direct attention to the physiologic reason why the squamous cancers of the kidney are so rare. Three conditions help to favor the production of cancer. One of these is the irritation which we have here in the presence of stone in the pelvis of the kidney constantly. The second one is the stasis found in the production of cancer in every cavity where it occurs. The third is the acid medium. In the kidney an acid medium is present all the time so long as the urine is normal, but so long as the urine is normal even in the presence of uric acid stone or oxalate of calcium stone, the irritation is slight because there is constant washing away of the surface by normal urine. On the other hand, as we have the development of stasis we have alkaline urine and the condition is no longer favorable to the formation of cancer. If we could have stasis and irritation and an acid urine at the same time, in this location, there can be no doubt that squamous carcinoma of the pelvis of the kidney would be common.

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ULCER OF JEJUNUM FOLLOWING GASTROJEJUNOSTOMY

WALLACE I. TERRY, M.D.
SAN FRANCISCO

During the winter of 1901, while in attendance at the clinic of the late Prof. Theodor Kocher of Bern, it was my good fortune to see him operate on a patient who had a perforating ulcer of the jejunum, following a gastrojejunostomy of the Roux or Y type. Up to that time only six similar cases had been reported, so it excited considerable interest. With the idea in mind that the gastric juice was responsible for these ulcers, I carried out experiments with various types of gastro-enterostomy, but in no case did ulcers of the jejunum develop. Later, in 1903, Watts reported the occurrence of two ulcers of the jejunum, one perforating, in a dog three months after a gastrojejunostomy. Exalto, Wilkie, Soresi and others found secondary ulcers of the jejunum following gastrojejunostomy in animals. Gronnerud of Chicago, in 1917, found ulcers quite frequently when the internal suture was nonabsorbable. In those cases in which absorbable sutures were used, ulcers of the jejunum were only occasionally encountered and were usually minute. The work of Gronnerud, based on some 5,000 experiments, is of great value in throwing light on this rather obscure condition. He concluded that ulcers of the jejunum, following gastro-enterostomy, were caused almost exclusively by nonabsorbable sutures. But this is not the only factor, as some of Gronnerud's, and Hartwell and Hoguet's experiments demonstrate, and as shown also by some clinical experience.

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It is my belief that the principal factor in the production of these ulcers is the introduction into the jejunum of non-neutralized acid gastric juice, and that trauma, be it from tight application of clamps, injuries of blood vessels or retained sutures, further lowers the resistance of the jejunum or of the anastomotic opening to the digestive action of the gastric juice. The fact that, in a series of 155 cases which I have collected from the literature, in addition to three cases of my own, only one case of ulcer of the jejunum followed gastrojejunostomy for cancer of the stomach, lends considerable weight to the idea that the gastric secretion is the prime factor. The duodenum has its own succus entericus with bile and pancreatic secretion to act as neutralizing agents, while the jejunum is much less able to protect itself against acid chyme.

When we come to investigate the type of operation which was followed by jejunal or gastrojejunal ulcer, we find that out of 136 cases collected by Wright,[1] posterior gastrojejunostomy was done in fifty-four (40 per cent.) while the anterior operation with or without entero-enterostomy was done in seventy-four (54 per cent.). In the remaining eight cases (6 per cent.) posterior gastro-enterostomy with entero-anastomosis was performed. The significance of these figures is apparent, for posterior gastrojejunostomy has undoubtedly been performed much more frequently than the anterior operation, yet fewer cases of jejunal ulcer have occurred following it. The further down the jejunum that the anastomosis with the stomach is made, the greater is the probability of development of jejunal ulcer; hence the greater number after the anterior operation because of the longer loop employed. A posterior gastro-enterostomy with entero-

1. Wright (Brit. J. Surg. **6**: 390, 1919) gives a list of nearly all reported cases. Other cases are recorded in Percy: Surg., Gynec. & Obst. **10**: 316, 1910. Carman, R. D., and Balfour, D. C.: Gastrojejunal Ulcers, Their Roentgenologic and Surgical Aspects, J. A. M. A. **65**: 227 (July 17) 1915. Urrutia: Siglo medico **64**: 470 (June 30) 1917; abstr. J. A. M. A. **69**: 678 (Aug. 25) 1917. Coffey: Ann. Surg. **71**: 303, 1920.

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anastomosis, or a Y operation, means deprivation of neutralizing agents to that portion of the jejunum attached to the stomach.

Just what element in the gastric juice is necessary, we are as yet unable to say. None of the reported cases give sufficient data as regards gastric analyses before, during and after the occurrence of jejunal ulcers. In a few cases, hydrochloric acid was almost entirely absent. Whether or not infection is a necessary concomitant is also a debated question. The fact that a considerable portion of the reported cases were marginal, that is, involving both the stomach and jejunum at the point of anastomosis, and the further fact that retained sutures have been found at the anastomosis, lend weight to the idea that the nonabsorbable suture is much to blame.

REPORT OF CASES

The following three cases have not been previously reported:

CASE 1 (7464).—Mr. J., aged 32, entered the University of California Hospital, June 4, 1914, with the history of a posterior gastrojejunostomy performed elsewhere three and a half years previously for pyloric obstruction. For twelve years he had had much gastric distress, often relieved by taking food or sodium bicarbonate. Eight years before admission, he had very severe acute abdominal pain which was in all probability due to a perforated ulcer of the duodenum, in view of the later operative findings. Vomiting had been a prominent symptom previous to the gastro-enterostomy. For two years after the operation he had been quite well, but a recurrence of his old symptoms had led to the performance of a second gastrojejunostomy, and he was told that the previous opening had almost entirely closed. The complaint which brought him to the hospital was pain, felt a few centimeters to the left of the umbilicus, and loss of weight and strength. Palpation revealed tenderness over the pain area. The roentgen ray disclosed a six-hour stasis in the jejunum just beyond the anastomosis opening and a closed pylorus. Dr. W. C. Alvarez, who had previously seen the patient, made a diagnosis of probable ulcer of the jejunum. At operation, June 12, after the freeing of many adhesions of the upper abdominal viscera, it was found that we were dealing with an ulcer in the efferent loop of the jejunum about 2 cm. from the anastomosis. The jejunum was firmly

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attached to the transverse colon at this point, and the ulcer had almost eroded through into the colon. The ulcer was excised, the raw surface on the colon was covered with a tag of omentum, and the open area of jejunum was made a part of the gastro-enterostomy by slightly enlarging the opening into the stomach. The internal suture was continuous silk, and the external was linen.

The patient remained fairly well for two months, when he had an attack of pain in the left side of the abdomen, followed in twelve days by hematemesis and the passage of bloody stools. Five months later he reentered the hospital with much the same complaint as before: epigastric distress, sour eructations and nausea, with occasional attacks of vomiting. Pain was often relieved by soda or food. Analysis of the stomach contents after a test meal revealed free hydrochloric acid 55, total acid 75. After the usual examinations, including the roentgen ray, a diagnosis of ulcer of the jejunum was made. At operation, Feb. 3, 1915, another ulcer of the jejunum was found in the afferent loop close to the stomach. This portion of the jejunum was excised and the proximal end implanted into the efferent loop, thus making a Y anastomosis. It was further found that the ulcer had perforated the wall of the jejunum posteriorly, the base being formed by the pancreas. The patient improved somewhat following the operation, but fourteen months later it was reported that he had died from intestinal hemorrhage. No necropsy was performed.

Case 2 (8216).—Mr. O., aged 43, entered the University of California Hospital, Nov. 15, 1914, complaining of pain in the right lower abdomen and vomiting blood. A gastro-jejunostomy had been performed a year previously at another hospital, there being found an old healed ulcer of the stomach near the pylorus with a recent ulcer in the second portion of the duodenum. The internal suture was chromic catgut and the external was linen, both being continuous. The pylorus was plicated. The patient remained well for only two months after the gastro-enterostomy. With the return of pain there was vomiting, and at one time a considerable amount of blood was vomited and also passed by rectum. The patient lost 30 pounds in weight. Examination revealed a tender mass 4 cm. to the left of the umbilicus; a test meal showed free hydrochloric acid 45, total acid 60; the Wassermann reaction was negative, and there was occult blood in the stools. A diagnosis of probable jejunal ulcer was made. At operation, November 16, a marginal ulcer was found nearly encircling the anastomosis; the lumen was thereby much narrowed and would just admit a finger tip. The pylorus was patent. It was felt that excision of those portions of the stomach and jejunum involved in the ulcer was unwise in view of the patient's poor physical condition, so a gastroduodenostomy

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was performed after mobilizing the third portion of the duodenum. The internal suture was made with chromic catgut and the external with linen. Recovery was without incident and at the last report the patient was all right.

CASE 3.—Miss A., aged 52, was referred to me in 1918 by Dr. Eliot Alden of Los Angeles, with a history of probable ulcer of the stomach extending back to the age of 25. In 1911, a posterior gastrojejunostomy was performed. Nine months later, pain began in the left colonic region, and in 1912, she had two hemorrhages, vomited blood and had tarry stools. In 1913, a pylorectomy was performed, but during the next four years there were attacks of pain to the left of the umbilicus and four more hemorrhages. A gastric analysis in 1915 revealed only slight acidity. Roentgen-ray examination, however, disclosed an unusual delay in the passage of barium in the jejunum just beyond the gastro-enterostomy opening. In view of the history of persistent pain to the left of the umbilicus, the frequent hemorrhages and the roentgen-ray findings, a diagnosis of jejunal ulcer was made and operation advised. This was carried out, Jan. 25, 1918. A gastrojejunal ulcer was found on the anterior wall with considerable distortion and contraction of the jejunum at that point. Excision of the entire ulcer and reestablishment of the anastomosis with tanned catgut sutures were carried out. Three months later the patient was operated on for acute gangrenous appendicitis. Two years later she had pain and tenderness in the epigastrium, which were diagnosed as recurrent ulcer, but the symptoms subsided promptly on an ulcer diet. Whether she will again have jejunal ulcer is for the future to tell.

In none of the foregoing cases were any retained sutures found, although search was made for them. To me, the striking feature in the symptoms presented by these three cases and by many others from the literature was the pain and tenderness to the left of the umbilicus. The beginning of the jejunum is just to the left of the spine and at the level of the second lumbar vertebra, while the umbilicus is opposite the third or fourth lumbar vertebra; so I am inclined to believe that the tender area is similar in type to the Head zones. Thus the Mayo-Robson point is not directly over the gallbladder, nor is the McBurney point directly over the appendix, but the tenderness is referred to those points. May it not be that the pain from an ulcer in the upper part of the jejunum is

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referred to a point from 2 to 4 cm. to the left of the umbilicus?

The value of careful roentgen-ray studies in the diagnosis of these ulcers has been emphasized by a number of observers. Perforation of the jejunal ulcers either into the peritoneal cavity or into the transverse colon has been reported in some fifty-five cases, most of them previous to 1910, so that it is fair to presume that earlier diagnoses have been made in the later cases. In many of the reported cases of acute perforation, there was a history of chronic antecedent pain or discomfort.

CONCLUSIONS

As a result of my study of jejunal and gastrojejunal ulcers following gastro-enterostomy, the following conclusions are offered:

1. The exact etiology still remains in doubt; in all probability the principal factor is the diversion of acid chyme into a part of the intestine, which has less neutralizing power than the duodenum. The other factors of prime importance are trauma, especially from retained sutures or anastomosis buttons, and infection.

2. In view of the very few reported cases of ulcer of the duodenum following pyloroplasty or gastroduodenostomy,[2] it would seem wise to employ those operations in suitable cases.

3. Gastro-enterostomy should be performed with much care; clamps, if used, should be adjusted without traumatism of the viscera; only absorbable sutures should be used for the anastomosis.

4. Patients subjected to gastro-enterostomy should be instructed as to a suitable dietary, which should be continued for at least a year. In addition, antacids should be given if the gastric analyses seem to warrant their employment.

2. Van Roojen: Arch. f. klin. Chir. 91: 381, 1910.

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5. Patients should be urged to seek competent advice when pain returns.

240 Stockton Street.

ABSTRACT OF DISCUSSION

DR. J. SHELTON HORSLEY, Richmond, Va.: Jejunal ulcer following gastro-enterostomy is found in a small, but definite, percentage of cases. It is, of course, caused by the gastro-enterostomy. Without this operation it is almost never found. Undoubtedly, unusual trauma and the use of unabsorbable sutures favor its occurrence, but when catgut is used and no clamps are employed jejunal ulcer sometimes occurs. In large clinics it is estimated that it follows gastro-enterostomy in about 4 per cent. of cases. It seems reasonable to assume, therefore, that something in the altered physiology of the stomach is responsible for the jejunal ulcer. When a hollow viscus has always had alkaline contents and the reaction is changed to strongly acid, symptoms are produced. For every jejunal ulcer there are probably many cases of jejunal hyperemia which also produce symptoms. In one of my cases in which a gastro-enterostomy was performed, without clamps, a perforating jejunal ulcer developed on the mesenteric border opposite the stoma. The best results follow gastro-enterostomy when done for complete pyloric stenosis, and the alkalinity of the duodenal contents cannot be lowered by the passage of acid contents through the pylorus. So the unreduced alkalinity of the duodenal contents can better protect the jejunal mucosa at the gastro-enterostomy opening than if this alkalinity had been reduced by the passage of the gastric juice through the pylorus. It is common experience to get the best result in those cases in which there is cicatricial pyloric or duodenal closure; in this type gastro-enterostomy should be done. In other types pyloroplasty will cure the ulcer and in a few months the stomach will appear to be practically normal even on roentgen-ray examination.

DR. WILLIAM J. MAYO, Rochester, Minn.: In our experience gastrojejunal ulcer rarely occurs if fine catgut instead of silk or nonabsorbable sutures are used in performing a gastro-enterostomy. This has also been Moynihan's experience. Twelve years ago I reported seven cases of these so-called marginal ulcers. I have seen very few true jejunal ulcers, but I have no doubt that they occur. They do occur experimentally in animals. The ulcers I have seen have almost always been in the suture line. In two cases, nonabsorbable sutures worked through the abdominal wall and were removed from superficial abscesses. A very narrow layer of tissue should be turned in, and one should be very careful about the blood supply. It has been my misfortune to reoperate in some cases of gastrojejunal ulcer in which

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the ulcer had been excised. We now cut off the gastrojejunostomy, close the stomach and jejunum, and make a pyloroplasty after the method of Finney. We have seen gastrojejunal ulcer only three times among many hundred gastroenterostomies in which catgut was used. Carman has shown that a roentgen-ray diagnosis of gastrojejunal ulcer can be made in more than 90 per cent. of the cases. Many of the patients coming back after gastro-enterostomy, with supposed relapses of the original ulcer, prove on exploration to have gastrojejunal ulcer with the original ulcer healed.

Dr. A. J. Ochsner, Chicago: The reason Dr. Mayo does not get jejunal ulcers following his gastro-enterostomies is not that he uses a certain kind of suture, but that he makes his gastrojejunal opening at the lowest point of the stomach so that there is no accumulation of acid gastric juice. In all the cases in which I have reoperated for jejunal ulcer there was a sacculation of the stomach. I have used silk in all my cases and my proportion of jejunal ulcer corresponds to Dr. Mayo's because I followed the principles he laid down twenty-five years ago.

Dr. A. A. Strauss, Chicago: When a gastrojejunal ulcer occurs, the surgeon has really produced an experimental ulcer. The etiologic factors which produced the original ulcer are still present. Producing the trauma to the bowel and stomach, using silk sutures and cutting off the blood supply by inverting the edges of the bowel and stomach too much, furnish the ideal conditions for producing an ulcer experimentally, especially when the etiologic factor, the infection, is still present in the body. Experimentally, we have found that if an ulcer is produced, and a gastro-enterostomy is performed later, during the very active stage of the ulcer, quite frequently a gastrojejunal ulcer is found, when silk is used. On the other hand, when the gastro-enterostomy is performed later, when the ulcer is practically healed, we hardly ever find a gastrojejunal ulcer. No matter whether we believe that a certain particular type of streptococcus produces the infection, the important clinical fact is that every excised ulcer contains a large number of organisms. The trauma of gastro-enterostomy plus the original infection produces the gastrojejunal ulcer. I doubt whether the acid conditions in the stomach play any rôle whatever in producing such an ulcer.

Dr. W. I. Terry, San Francisco: The acid chyme is the prime causative factor. Dr. Mayo brought that out in a different way. His therapy is to do a pyloroplasty. This means that he restores the acid chyme to the duodenum instead of allowing it to go back into the jejunum. That seems to me to be the logical treatment for these cases. The matter of roentgen-ray diagnosis is certainly very important.

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SURGERY OF CANCER OF THE LARGE INTESTINE

ARTHUR DEAN BEVAN, M.D.
CHICAGO

During the last twenty years a great deal of work has been done in the treatment of carcinoma of the large intestine. Many men have attacked this problem, and a great many different operative plans have been introduced and tried out. I have been much interested in the problem during this period and have run the gamut of the various plans that have been presented. From our experience I think we have been able gradually to crystallize some general principles that are essential in the handling of these cases, and I shall briefly and informally present the conclusions I have arrived at as a result of the work I have done in my own clinic.

DIAGNOSIS

Before considering the surgical therapy, I would like to make a short statement in regard to the diagnosis of carcinoma of the colon, simply emphasizing the great importance of careful roentgen-ray study of these cases. The roentgen ray is not infallible in the diagnosis of cancer of the colon, but it has been developed to a point at which it is certainly the most valuable single piece of evidence that we can obtain in these cases. I would not belittle the great value of a carefully obtained clinical history and physical examination of the patient, because these are essential, and are often the basis of determination; but in the absence of a palpable tumor the roentgen ray is absolutely essential to determine by the presence of a filling defect the location of the neoplasm, and it is of great importance in the subsequent management of the case, in determin-

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ing the shape and location of the abdominal incision. In the overwhelming majority of the cases careful roentgen-ray examination, fluoroscopic and plate, gives definite and absolute evidence of the existence and location of the carcinoma of the colon. I find, however, that there are some exceptions to the rule. In some cases of carcinoma, at the hepatic and splenic flexures the overlapping of the shadows of the barium in the bowel make it impossible in the plate to see any filling defect, and even in fluoroscopic examination it may be difficult to demonstrate any abnormality. Cases of this kind, however, are certainly the exception and not the rule. In the presence of obstructive symptoms it is frequently not desirable or possible to obtain a roentgen-ray examination before operative interference is undertaken, and here, of course, the diagnosis must be based on the history and clinical picture.

SURGICAL THERAPY

As my experience has grown in these cases, I have been convinced of the great value of preliminary colostomy in the presence of obstruction. In the absence of definite evidence as to the location of the obstruction and in cases that come to us greatly distended, we have adopted the general plan of making an oblique muscle-splitting incision on the right side and either a colostomy using the cecum, or if the cecum itself is involved, an ileostomy, to relieve temporarily the obstruction. The plan that we have adopted is a very simple one and the operation is usually done under local anesthesia (Fig. 1); a muscle-splitting incision, such as that employed in an appendix operation; the pulling into view of the cecum or ascending colon or ileum; passing a single suture through the skin and superficial fascia, muscles of the abdomen, and peritoneum, using a noncutting needle; then transfixing the mesentery of the bowel close to the bowel itself; then bringing the suture out through the opposite side of the incision and fastening the two ends

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of the suture to a large sized bone or porcelain button, about an inch in diameter; then closing the balance of the skin incision with black silk suture and making no effort whatever at suturing the peritoneum to the bowel, and covering the entire field with a thick, sterile zinc oxid paste. We then introduce into the proximal loop through a small puncture a No. 12 or 14 American scale catheter, which is held in position by two purse-string sutures of Pagenstecher linen. This we regard as a point in the technic of great service, as it secures at once a relief of the gas tension, making the patient much more comfortable. If the small catheter becomes obstructed, it is readily washed out with a little physiologic sodium chlorid solution or sterile olive oil. The colostomy is completed at the end of about three days by taking an electric cautery and enlarging the puncture opening, which has been used to introduce the catheter, to the desired extent, usually about one-half or three-fourths inch.

Too great emphasis cannot be put on the life-saving value of colostomy or ileostomy in the presence of obstructive symptoms in these cases of carcinoma of the colon. After the obstructive symptoms have been relieved by the preliminary colostomy, or in the cases of cancer of the colon in which no obstructive symptoms have as yet developed, it is essential for us by roentgen-ray examination to determine the presence of the cancer, if one exists, and to determine its exact location.

THREE BASIC PRINCIPLES

In the technic of removing carcinoma I have learned from experience the importance of three basic principles:

1. All of these cases can be best handled through four different incisions, namely, a muscle-splitting incision like an appendix incision on the right side; a similar one on the left; a large S-shaped incision on the right side, and a similar one on the left (Fig. 2).

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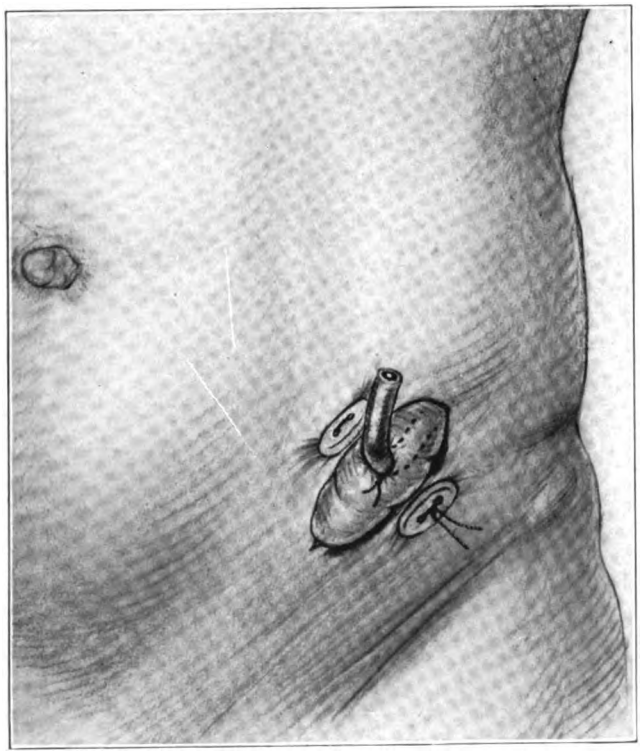

Fig. 1.—Preliminary colostomy.

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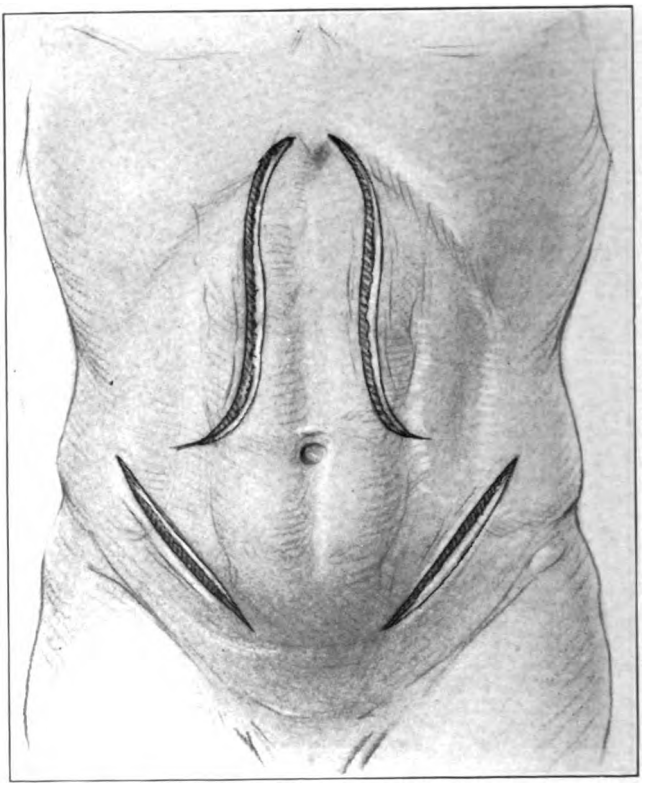

Fig. 2.—Incisions.

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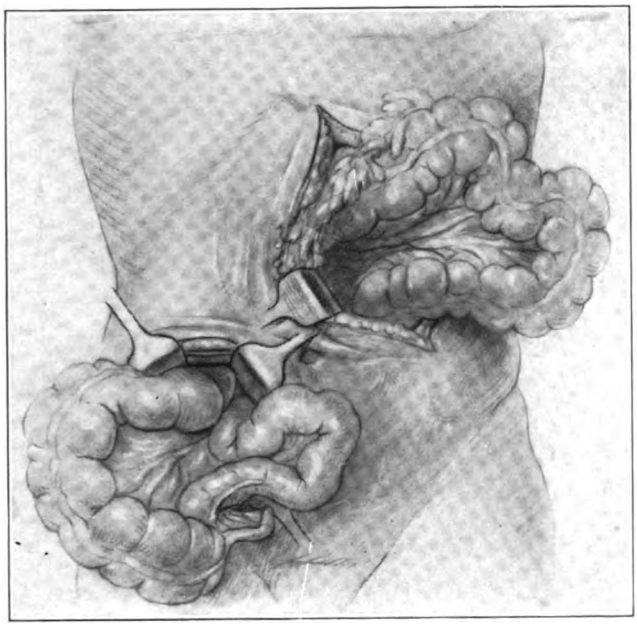

Fig. 3.—Mobilization of bowel.

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Fig. 4.—Lateral anastomoses of colon at splenic flexure.

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We now seldom use the midline incision, although in carcinoma of the transverse colon close to the center of that section of the bowel, a midline incision above the umbilicus is, of course, indicated.

2. It is essential in the removal of any portion of the large intestine from the cecum to the rectosigmoid to mobilize very fully that section of the bowel which is involved in the process and in the operative procedure. For instance, it is possible by dividing the outer layer of the mesocolon from the cecum to the rectosigmoid to mobilize the entire large bowel and bring it out of the abdominal incision. In the practical application of this principle to a given case it is necessary, of course, simply to mobilize the bowel for a sufficient length to enable us to resect the cancer and to secure a good anastomosis without any tension (Fig. 3).

3. The third basic principle which we have learned to recognize is the importance of a side-to-side anastomosis in big bowel surgery. We are thoroughly converted to the view that, after mobilizing the colon widely and resecting the carcinoma, doing this, of course, with a large margin of safety as far as the extent of the excision is concerned, the proper technic is to close both ends of the intestine by crushing, ligating and invaginating with Pagenstecher linen, and then making a side-to-side anastomosis as we do in gastro-enterostomy (Fig. 4). The mortality, as I obtain the evidence from my own clinic and from the literature, is about one-half as great in properly performed side-to-side anastomoses as in properly performed end-to-end anastomoses of the large bowel, and because of that fact end-to-end anastomoses should be practically discarded.

TWO GROUPS OF CASES

In the practical handling of these cases we should, of course, divide these cancers of the large intestine into two distinct groups: first, those in which there

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are no obstructive symptoms, and second, those in which obstructive symptoms already exist. In those cases in which there are no obstructive symptoms, the case can be cleaned up in one operation by following the general principles of technic which I have just described: in carcinoma of the cecum or ascending colon, an oblique incision on the right side, with free mobilization of the colon up to the hepatic flexure, or even including the hepatic flexure if this is necessary, which is quite possible by our muscle-splitting incision carried well backward in the flank. In carcinoma of the hepatic flexure or upper part of the ascending colon or right portion of the transverse colon we employ our S-shaped incision on the right side; in carcinoma of the central portion of the transverse colon, a midline incision above the umbilicus; in carcinoma of the splenic flexure or in mobilization of the splenic flexure, a large S-shaped incision on the left side; in carcinoma of the descending colon or sigmoid a large muscle-splitting incision on the left side.

Immediate closure in these cases should be made, with drainage well down through the peritoneum to the site of the anastomosis, with a small cigaret drain, which is to be left in place from twenty-four to forty-eight hours.

The cases of cancer of the colon that come to us with obstructive symptoms present a more difficult and complicated picture. If we have definite knowledge of the location of the carcinoma we can plan the colostomy, which is essential as a preliminary step, to the best advantage; for instance, if we know that the sigmoid is involved, we can employ the sigmoid or descending colon for our colostomy opening, if the colostomy is to be permanent. If, however, it is but temporary, a colostomy in the cecum is preferable, as it leaves us a free, clean field for the resection. When, however, there is any doubt as to the location, as I have just stated, we should make it a rule to make a

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right sided muscle-splitting incision and employ the cecum, ascending colon or the ileum. When the condition of the patient warrants, at the same time that the colostomy is made the hand should be introduced into the peritoneal cavity and a thorough exploration made to determine the exact location of the primary lesion and the question of metastases or radical lymphatic involvement. In some cases, however, when the condition of the patient is bad and the operation is performed under a local anesthetic, this general exploration of the abdominal cavity may be difficult or inadvisable. If the patient recovers from the obstructive symptoms after the colostomy is made, then a careful fluoroscopic study of the colon is later undertaken; and, if the condition warrants, later a radical resection is to be undertaken.

THREE-STEP OPERATION VERSUS THE MIKULICZ OPERATION

You will notice that I have not mentioned the Mikulicz operation as yet in this discussion. Many surgeons in handling cases of cancer of the colon employ the Mikulicz operation in a large percentage of their operations. I want to submit a plan we have adopted in our clinic which I believe is of much greater service than the Mikulicz operation. This is what we call the three-step operation. I can best describe it by giving the history of some of the typical cases in which we have employed this method.

CASE 1.—A year ago a woman, aged 40, was brought into our clinic with obstructive symptoms of a moderately severe degree. She was quite distended, although her general condition was fairly good. Fortunately, Dr. Ralph Brown had obtained a fluoroscopic examination and some roentgenograms of the case before the obstructive symptoms developed, and these revealed a filling defect about the middle of the sigmoid. Because of the obstructive symptoms I first made a muscle-splitting incision on the right side, brought up the cecum with our button suture, and performed the colostomy which I have described. Within four weeks she was in very good condition, the artificial anus functioning very satis-

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factorily, and she was in a condition to stand the radical operation of resection. I then made a muscle-splitting incision on the left side, resected the carcinoma, which was located at about the center of the sigmoid, and made a side-to-side anastomosis. She made an excellent recovery from this operation. Four weeks later, under a local anesthetic, I closed the colostomy opening on the right side. The patient is now in excellent condition, has regained her former weight, and has made a perfect recovery. She has on her abdomen two oblique incisions like appendix incisions, one on the right and one on the left side, perfectly clean, fine scars without any tendency to hernia or bulging, and she is, in fact, quite normal in every way.

CASE 2.—A man, aged 65, was brought into my clinic, the extreme picture of obstruction. We had absolutely nothing to guide us as to the location and cause of the obstruction. Under local anesthesia I made a right-sided muscle-splitting incision, found the enormously dilated cecum, and made a colostomy with our button suture method, with immediate relief by introducing a catheter into the caliber of the intestine. The man was in such a serious condition that it took six or seven weeks for him to recover sufficiently to warrant the radical operation. In the meantime careful examination revealed a small circular carcinoma at the splenic flexure.

The second step in the procedure was an S-shaped incision on the left side, free mobilization of the splenic flexure and the transverse and descending colon, and resection of the carcinoma, and side-to-side anastomosis. Four weeks after the resection of the cancer the third step of the operation was performed, and under local anesthesia the colostomy was closed. He now has a perfectly clean scar like an appendix scar on the right side, and a perfectly clean S-shaped incision scar on the left side.

This three-step operation in the presence of obstruction to my mind is very much more satisfactory than the Mikulicz operation. It is, I believe, a safer procedure and one that is in no way blind. It secures immediate relief from the obstruction, it enables us to make a much more radical operation of resection of the carcinoma than does the Mikulicz, and it is much more satisfactory to the patient than the Mikulicz plan.

Carcinomas from the cecum to the lower part of the sigmoid, which can be handled after the method I have outlined and which are limited to the primary focus, give an excellent prognosis of permanent cure if early

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recognized and radically removed. Carcinomas of the rectosigmoid form a peculiar, unfavorable group both from the standpoint of the practical management of the operative technic and from the standpoint of ultimate prognosis. I have here run the gamut of the various methods that have been advocated. I am now in a position to present my views without having any longer much question as to the best plan of procedure. My views are these: that in carcinoma of the rectosigmoid a wide mobilization through the abdomen should be undertaken, the carcinoma removed, a left inguinal colostomy made, when feasible the rectum invaginated and excluded from the peritoneal cavity by purse-string sutures, and when advisable, of course, from the extent of the involvement, removal of the entire rectum. One must use good judgment in determining this matter. There is nothing to be gained by the removal of the lower 4 or 5 inches of the rectum which is in no way involved. If the carcinoma of the rectosigmoid is limited and can be completely removed, the lower portion of the rectum should be allowed to remain.

In carcinomas of the rectum itself we are employing with great satisfaction, if the carcinoma does not extend up into the bowel more than 3 or 4 inches and is not too extensive, a method of splitting the rectum posteriorly after removal of the coccyx, bringing the entire operative field well into view and in just the same control as one might an epithelioma of the lower lip, then cutting out the lesion with the electric cautery, saving as much of the rectum as is absolutely free of disease, closing with catgut suture the raw surface from which the carcinoma has been dissected, packing with iodoform gauze, and obtaining, as we must necessarily in these cases, wound healing by granulation. We have been gratified to find what good control the patients have secured after very extensive local operations for carcinoma of the lower 3 inches of the

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rectum. These operations are, of course, of the atypical type. We have a number of patients who have been operated on two, three, four and five years ago and who report to us regularly that they are free from recurrence and that they have very satisfactory control.

Finally, there is a limited group of cases in which the rectum is so extensively involved that the best procedure seems to be a Kraske operation, with complete removal of the rectum and the making of a sacral anus. We have learned, as other surgeons have learned, not to force the Kraske operation to cover too extensive a field and to attempt to remove not only the rectum but the rectosigmoid and part of the sigmoid itself by this method, because although most of the patients survive and many give very satisfactory results, there is too great a possibility of necrosis from cutting off of the blood supply when this is undertaken. Such cases are preferably handled through the abdominal route.

One final word from our experience, regarding the tube resections that seem so attractive on paper and have been so widely employed: Our own experiences have been that although we have had some very satisfactory results, on the whole the tube resection should be discarded.

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CANCER OF THE RECTUM

G. W. CRILE, M.D.
CLEVELAND

The ideal for the surgical treatment of cancer of the rectum, as of any other pathologic condition, is maximum operability, maximum percentage of permanent cures, and the reduction of the immediate mortality to zero.

The possibility of a permanent cure of cancer of the rectum by operation depends more on the stage at which the case is presented for operation than on even the most thoroughgoing technic; but maximum operability, which means a safe operation with the removal of the maximum amount of tissue surrounding the cancer, is a possible attainment.

To cancers which involve the lumbar muscles, which penetrate the bladder, which involve the liver, etc., operability does not apply. Such cases are inoperable. When we speak of increased operability we mean that the technic has been so improved that all but the anatomically inoperable are given the maximum chance for survival.

We believe that this implies such surgical control that any method—the posterior, the combined, the abdominal—may be used with equal facility to afford the maximum chance of permanent cure.

The evolution of the management of these cases has followed lines analogous to those by which the management of exophthalmic goiter cases was developed; that is, the operation is individualized—the type of operation and of postoperative care follows the anatomic and pathologic indication. In brief, procedures follow indications—not rules.

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Reports of mortality attending operations for cancer of the rectum are given in the accompanying table.

RADICAL OPERATIONS FOR CANCER OF THE RECTUM

I. STATISTICS COLLECTED BY VARIOUS REPORTERS

Reporter	Date of Report	Number	Mortality, per Cent.
Tuttle (Table I)	To 1895	457	22.4
Tuttle (Table II)	1895-1892	512	20.0
Tuttle (Table III)	1892-1897	259	11.7
Ball	1896	175	16.5
Billroth	1896	606	58.9
Gross	1896	198	20.8
Kelsey	1896	140	15.7
MacCosh	1896	439	19.1
Veljaminoff	1896	225	20.5
Krönlein	1900	881	19.4
Hartwell (group of N. Y. surgeons)	1905	46	20.0
Chalier and Perrin	1913	206	40.86
Hartman	1913	1,605	15.8
J. M. Lynch	1918	225	16.0

II. INDIVIDUAL STATISTICS

Kraske	1892	80	18.7
Poppert	1906	68	6.2
Rotter	1906	42	4.8
Cripps	1907	85	4.7
C. H. Mayo (Mayo Clinic)	1916	430	15.5
C. H. Mayo (Mayo Clinic)	1916	(1912-1915)	12.5
Bull	1919	44	11.4
G. W. Crile and associates	1920	72	9.7
G. W. Crile (personal, last series)	1920	20	0.0

III. TOTAL SERIES OF OPERATIONS FOR CARCINOMA OF THE RECTUM, INCLUDING COLOSTOMIES FOR OBSTRUCTION

G. W. Crile and associates	1920	158	12.5
G. W. Crile (personal, last series)	1920	38	0.0

A critical examination of the causes of death as reported in the literature and as found in our own series showed that the principal cause was not hemorrhage or shock, but that death was generally due to infection and to the absorption of the toxins of feces. A laboratory investigation showed clearly that the effects of the injection of the toxins of feces were surprisingly poisonous. This fact, associated with the fact that there exists a large surface for absorption in the field of operation, gave an important clue. It followed that the first surgical step should be the complete diversion of the fecal stream by a preliminary

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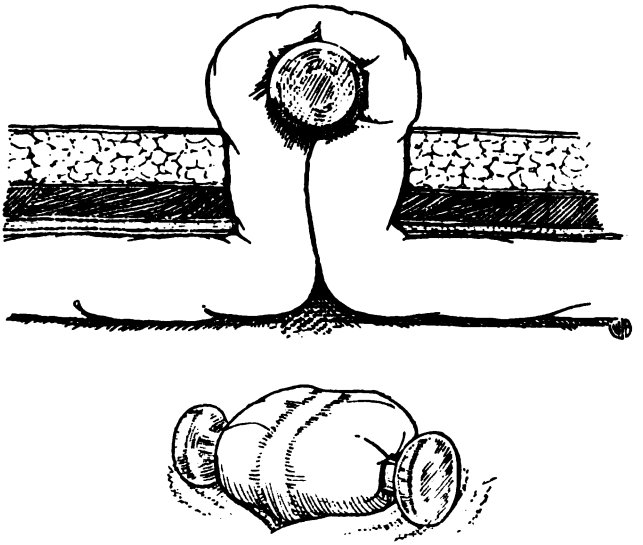

Fig. 1.—Angulation of colon by short flanged glass tube.

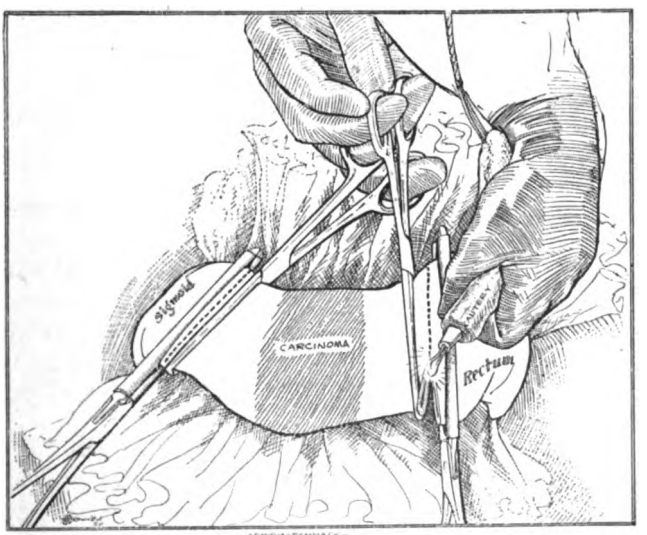

Fig. 2.—Technic of excision of cancer of the rectum: excision of carcinoma.

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colostomy. This is usually performed under analgesia and local anesthesia, and causes but little depression. We are satisfied that the best colostomy is of the Littlewood type, i. e., an intramuscular incision below the border of the ribs. The Sistrunk technic answers well also. The incision for the colostomy is made large enough to ascertain whether or not there is involvement of the liver or of the lymphatic glands, as well as the extent of the local invasion. Of prime importance is the management of the colostomy so

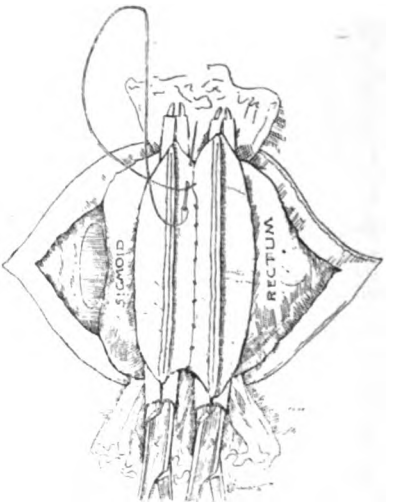

Fig. 3.—Technic of excision of the rectum: continuous right angle stitch.

that every particle of the fecal stream is diverted and none passes through the rectum. This is accomplished by a sharp angulation of the colostomy, which is secured by the insertion of a short flanged glass tube under the loop of colon and on the surface of the skin (Fig. 1).

At the end of a week, or as soon as both the local and the general condition warrant it, the major operation is performed (Figs. 2-6). Whether the technic is intra-abdominal or posterior or the combined operation, a wide excision of the growth and of

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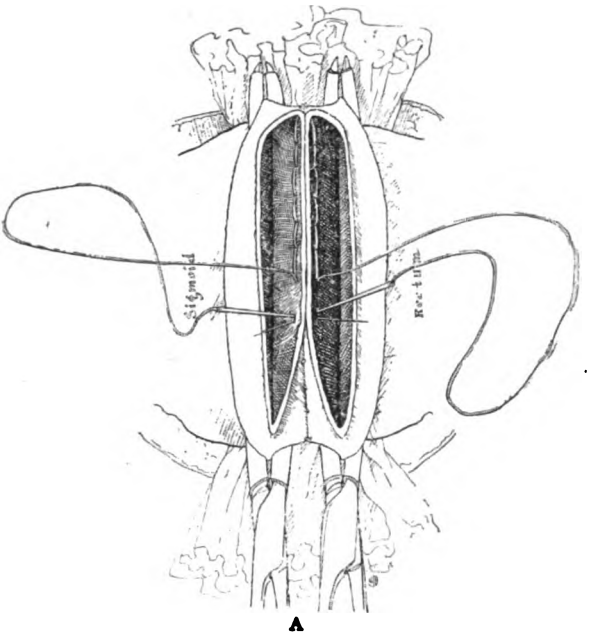
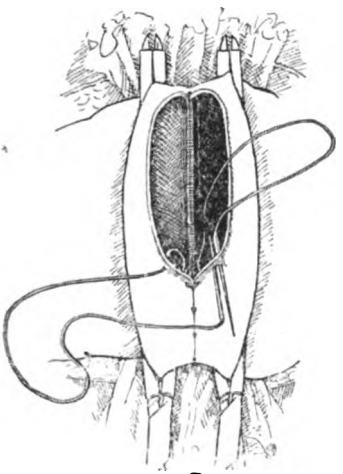


A



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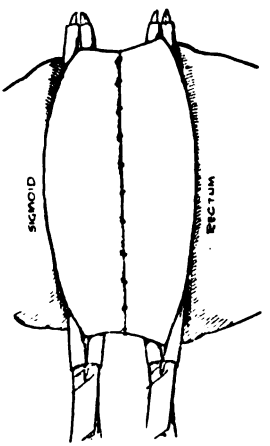

C

Fig. 4.—Technic of excision of cancer of the rectum: closure of end-to-end anastomosis; *A*, cobbler stitch (Step 1); *B*, cobbler stitch (Step 2); *C*, cobbler stitch complete.

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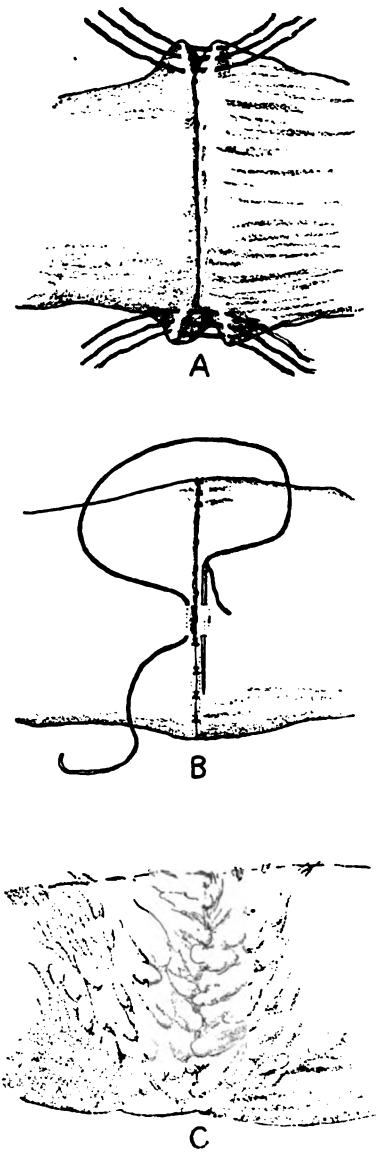

Fig. 5.—Technic of excision of cancer of the rectum: closure of end-to-end anastomosis; *A*, stay sutures; *B*, interrupted right angle stitch over cobbler stitch; *C*, complete anastomosis.

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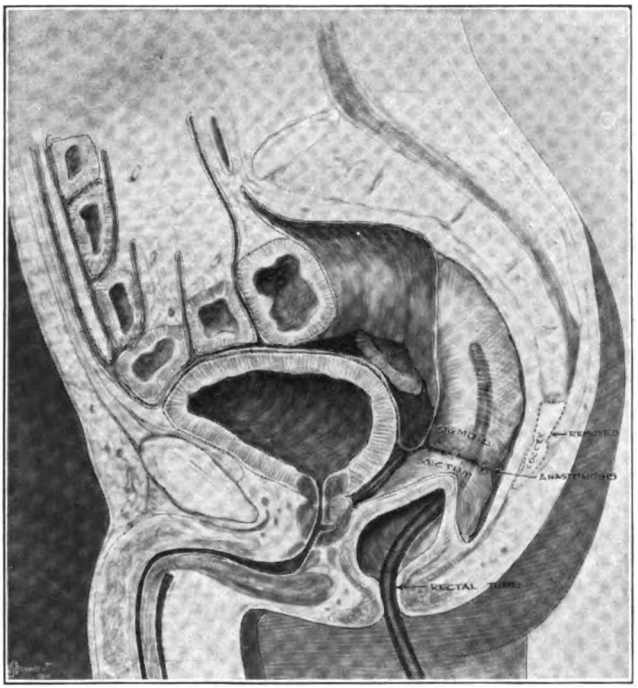

Fig. 6.—Technic of excision of cancer of the rectum: carcinoma of the rectum excised; sigmoid secured to rectum by cobbler stitch; rectal tube inserted.

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the surrounding structures is made. If an end-to-end anastomosis is made, a rectal tube (Mayo) is passed through from the anus. Infection of the field is at first controlled by means of packing with iodoform gauze well wrung out; but as soon as the suture line is secure, the Carrel-Dakin method is employed. The wound must be kept clean at all times. Because of the colostomy, nourishment need not be suspended and the bowels may move.

If the operation is extensive and of a nature to presuppose the development of peritonitis, or should peritonitis unexpectedly appear, the opium-water-posture-heat method is at once inaugurated. This method is all but specific.

Should there be secondary anemia, a blood transfusion is made promptly without waiting to discover whether the patient is going to do well or ill. As in the treatment of shock, it is a grave error to allow a patient to remain in a state of low blood pressure in the hope that he will improve through his own resources, reserving a blood transfusion to be used as a last resort after it has become apparent that the patient is going to die.

Should healing be retarded, a blood transfusion is made.

Whatever his condition, the patient is given the benefit of a dietetic and hygienic regimen identical with that for tuberculosis—forced feeding and fresh air in abundance.

When the intestinal healing is complete, and not until then, the temporary colostomy is closed by a plastic operation and the sigmoid loop dropped back into place.

Our confidence in the value of these procedures is based on a comparative study of seventy-two operations for cancer of the rectum performed by my associates and myself with a mortality rate of 9.7 per cent.

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My series, since the foregoing plan has been followed, consists of thirty-eight operations, twenty of which have been radical with no death.

The end-results of this series will be reported in a later communication.

ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. BEVAN AND CRILE

Dr. Daniel F. Jones, Boston: Dr. Bevan brought out points which will help to lower the mortality from carcinoma of the colon. There are two principal reasons for the great improvement in our statistics: first, the mobilization of the colon, for which, I believe, Dr. Mayo is responsible, and, second, providing a safety valve which Dr. Bevan does by a colostomy or a cecostomy. There are several other methods of obtaining relief from gas above the line of sutures; one is an enterostomy by the Witzel method, as suggested by Dr. Charles Mayo; another is by putting a tube through the anastomosis from the anus. No improvement has been made in the great majority of surgical conditions, except through the cooperation of the general practitioner. We talk much about the improved technic of operations for acute appendicitis as being responsible for the lower mortality rate, but as a matter of fact, the real reason is that the family physician sends these patients to us early. Our results in cases of carcinoma of the colon and rectum will be bad until the family physician sends these patients to the surgeon early. The general practitioner cannot be expected to make a diagnosis of carcinoma of the colon, but if he knows the suggestive symptoms, he can send the patients to some one who can make the diagnosis, and then early operation can be made. In many parts of the country the general practitioner takes it on himself to determine whether the case is an operable one or not. He usually determines that it is not operable. The surgeon is the only one to determine this question, not the general practitioner. Dr. Crile leaves no room for argument. Statistics are of little value, however, unless it is known in what percentage of cases seen by the surgeon an operation was performed. For instance, Cripps saw 409 cases and operated in 100. His percentage of cures was very high, and his mortality was low. Dr. Crile is right in suggesting that a colostomy be done first, as in carcinoma of the colon. In the combined two-stage operation, the colostomy is always done as the first stage; this gives an opportunity to remove the rectum at the second operation with very little disturbance to the patient. The convalescence is made safe by keeping the wound in good condition by the use of the Carrel-Dakin method. Dr. Crile's record of twenty cases without a death

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is very remarkable. I think we can all approach this, however, if we carry out his suggestions.

Dr. William J. Mayo, Rochester, Minn.: There is no doubt that the principles Dr. Bevan laid down and Dr. Crile's advice with regard to the care that should be given these patients after operation will improve results in these cases materially. The question of operability is interesting. In most large hospitals the patients are sent in for operation not by skilled men of large experience, but by men of less experience, and a very large percentage are sent home from the dispensary as hopeless cases. I think that this is true of practically all the large hospitals of this country in the ordinary dispensary form of examination. In our early work in this field we had a low mortality, about 5 per cent., and a high percentage of cures, between 50 and 60; but 75 per cent. of the patients who came to the clinic, taking them as a whole, were sent home as hopeless cases. Only thirteen of one hundred patients were alive and well after five years, and we had the paradox of a low mortality and a high percentage of cures, yet few cures. We increased operability up to an average of 70 per cent. and we had twenty-seven instead of thirteen patients alive at the end of five years, but the mortality percentage had gone up and the cures had come down. It is difficult to study this question from the standpoint of mere incidence of mortality. The patient and the patient's family and the friends are not very happy over a permanent colostomy, and when the patient is told that by a permanent colostomy the mortality will be reduced about 10 per cent., he will take the increased risk if he has a reasonable chance of having his bowels move in the normal manner. It is a fact that the price the patient must probably pay for the opportunity to recover from the operation and remain well is a permanent colostomy. I shall look into the operation described by Dr. Bevan with great interest because he says function is preserved. I have had many patients who after radical operation have a controllable anus in the normal situation, and are alive and well for many years. For the present, a permanent colostomy will be necessary in the majority of cases, but earlier operation and better technic will secure more desirable results.

Dr. H. J. Waring, London, England: Dr. Bevan's paper bears out to a great extent my experience. In my early days of surgery, I found that in carcinoma of the large intestine, if one attempted resections with end-to-end anastomosis the mortality was very high. I soon learned, however, that one of the main causes of this was the inability of the bowel in which there is obstruction to join on the part in which there is no obstruction. So I early adopted the principle of making a colostomy on every patient who had a growth in the large intestine. Two of the incisions I made resembled those of

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Dr. Bevan's, one on the right side and the other on the left side, an oblique muscle splitting incision. In the upper one I did not make an S-sharped curve. I almost invariably make a vertical incision within the lateral margin of the rectus abdominis, splitting the posterior sheath. I have found by experience that in the majority of cases this incision gives a strong abdominal wall. I also adopted the third method: first, colostomy; second, excision of the growth, side-to-side anastomosis and later closure of the colostomy. I cannot give statistics from memory. All I can say is that the mortality has been decreased enormously. As regards the surgery of carcinoma of the rectum, I have had to a considerable extent the experience of Dr. Charles Mayo. In England, whether it is owing to the inferior education of a considerable number of the general practitioners, or because of the desire of the patient not to come under observation at an early stage, a very large proportion of patients come at a late stage of the disease. When an inguinal colostomy is done, an incision is made to introduce the hand into the interior of the abdomen to make out the primary disease and secondary invasion in the adjacent structures. When that has been done, the decision is made as to what the further procedure shall be. In regard to the method of colostomy, I always create a well marked curve. I generally bring the colostomy mattress suture behind the bowel and bring the loop of the bowel over, putting in two sutures. Mr. Harrison Cripps, whom I assisted for some time, selected his cases carefully. His operations were done entirely by the peritoneal route, except in well localized cases of the disease. If the growth was adherent to parts around or extended beyond, and was not freely movable, then an excision was not done, but a colostomy.

Dr. George W. Crile, Cleveland: Inasmuch as I did not describe the technic, I may have left the erroneous impression that the colostomy is permanent. This is not so; the colostomy is merely temporary. At the resection an end-to-end anastomosis is made, and cutting off the entire fecal stream at a point above is vitally important, especially when the posterior operation is performed, which leaves a large absorption area. After the anastomosis is healed, then, as Dr. Bevan has described, the temporary colostomy is closed and returned. I do not advise operation in the following groups of cases: first, if there is any involvement of the liver; second, if there is penetration into the bladder or prostate, and, third, if the penetration goes into the lumbar muscles. In the absence of these conditions I always attempt a radical cure. By assembling a plan of procedure by means of which the operation is rendered relatively safe we are able to extend the operability accordingly and to widen the scope of operation. Only in exceptional cases have I failed to secure anastomosis of the intestine and normal defecation.

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PNEUMOPERITONEAL ROENTGEN-RAY DIAGNOSIS

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AND
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A quarter of a century has not yet elapsed since the discovery of the roentgen ray, but during this relatively short interval the adaptation of roentgenography to diagnostic purposes has rapidly progressed and many new fields of investigation have been opened up. After a period characterized by many additions to and improvements on the apparatus and technic, an entirely new combined method of diagnosis has been found which assists the roentgen ray in the revelation of obscure diseased conditions by the inflation of body cavities with air or gas, thereby increasing to an extent hitherto unobtainable its scope and diagnostic efficiency. Experience with this procedure, although as yet necessarily brief, would appear to justify the statement that its adoption already means a great step forward, and will probably come to be regarded as an epochal advance in diagnostic roentgenology.

The development of this method has already been shortly outlined by us in a preliminary report.[1] Since our adoption of this promising method in the spring of 1919, we have endeavored by improving on the technic to show distinctly the parenchymatous organs themselves and their mutual relations, as well as pathologic changes of these organs, and our experience

1. Stein, Arthur, and Stewart, W. H.: Ann. Surg. 70: 95 (July) 1919; Am. J. Roentgenol. N. S. 6: 533 (Nov.) 1919.

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with the application of this method of abdominal inflation to roentgenographic purposes has yielded very satisfactory results, and has more than justified our expectations as to its diagnostic value. The procedure has been utilized by us in eighty cases, and without untoward effects. The list includes patients varying in age from 4 to 74 years. The feasibility of the method with children is well shown by a recent diagnostic inflation of a 9 year old boy with a possible indefinite right-sided mass in the region of the diaphragm, two weeks after the performance of an appendectomy. The inflation was accomplished without the slightest difficulty and with no pain whatever to the patient, and it proved that no subdiaphragmatic condition was present. The patient left the hospital cured, three weeks after the operation.

We believe that the method should be reserved for those obscure cases in which a clearer outline than that which can be secured under the ordinary roentgenographic arrangements is desired.

TECHNIC

Since our last publication on this subject we have further simplified the application of this method and by so doing have added to its safety, simplicity and efficiency. Practically the only accessories now required are the lumbar puncture needle, rubber tube and oxygen tank. In this respect we are in accordance with Rautenberg [2] who, in his latest contribution to this subject, has further simplified the technic of the method, the implements mentioned above being all that he now requires in its application.

The lumbar puncture needle and the rubber tube are thoroughly sterilized. The tube is then connected with the oxygen tank and the apparatus is ready for application.

2. Rautenberg, E.: Pneumoperitoneale Roentgendiagnostik, Deutsch. med. Wchnschr. 45: 203 (Feb. 20) 1919; Neues zur Roentgenologie der Leber, ibid. 46: 123 (Jan. 29) 1920.

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The patient is prepared for this procedure as for any roentgen-ray examination by a thorough cleaning out of the bowels and emptying of the bladder just before inflation. We have also found it advisable to administer one-sixth grain of morphin half an hour before pneumoperitoneum is established.

The usual point at which the needle is to be inserted is about one to two finger breadths below the umbilicus in the median line. The skin in this vicinity is thoroughly cleaned with tincture of iodin. Existing scars are to be avoided when inserting the needle, and that location should be selected where it is reasonable to expect that no adhesions will be encountered.

We have found that a local anesthetic before introduction of the needle is entirely unnecessary. Merely taking a fold of the skin tightly between the fingers is sufficient to counteract any pain on introduction of the needle.

The needle should be slowly inserted as far as the fascia, the thickness of the abdominal wall being easily gaged by any surgeon. A very gentle pressure will then ease the needle through the fascia and peritoneum into the abdominal cavity. It is our custom to insert the needle always at a slightly oblique angle so that the point of the needle after entering the abdominal cavity remains as near to the parietal peritoneum as possible. The free end of the rubber tube having been connected with the needle, the oxygen is then allowed to flow gently into the abdominal cavity. The amount of gas varies from 2 to 4 liters according to individual conditions. Observation of the patient's general condition will assist the surgeon to judge the fulness of the abdominal cavity. We regard this method as strictly surgical and one that should be attempted only by one with surgical experience.

The air or gas used in the application of this method does not necessarily need to be sterilized. Rautenberg in his latest contribution [2] points out that the atmos-

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pheric air or oxygen which is introduced into the abdomen does not need to be filtered or sterilized; and Schmidt,[3] who in his application of the method uses ordinary unsterilized air, emphasizes the fact that such air never gives rise to the slightest infection or even irritation of the peritoneal cavity. Our experience, based on eighty cases, fully confirms these statements.

DANGERS

The whole method stands and falls with the question of any untoward effects or dangers that may be connected with it. Experiments and our own practical experience have shown that the elasticity of the living intestine permits it to recede before a sharp intruding body such as a needle, and no trouble in this respect has ever been encountered by us. The nonoccurrence of injuries when this method is used was demonstrated in Rautenberg's preliminary animal experimentation on guinea-pigs, nor were lesions of the omentum or small intestine demonstrable in a few patients who came to necropsy or operation some days after the employment of this procedure. We ourselves have looked for intestinal lesions in patients at the time of operation, but have invariably found the intestine unharmed. The entire freedom from danger is also emphasized by Alvarez[4] on the basis of personal experience.

PAIN

We have noticed that about one third of our patients complain of marked pain in the shoulders following distention of the abdomen to its full capacity. No heart symptoms have accompanied the inflation except a slight rise in pulse. Before using the deflation method, we found that occasionally the pain did not begin until late in the evening. In this event, it is

3. Schmidt, Adolf: Ein neues Verfahren zur Roentgenuntersuchung der Bauchorgane, Deutsch. med. Wchnschr. 45: 201 (Feb. 20) 1919.

4. Alvarez, W. C.: The Radiographic Study of the Abdominal Organs After Inflation of the Peritoneal Cavity, California State J. Med. 18: 42 (Feb.) 1920.

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advisable to elevate the foot of the patient's bed in accordance with the principle that air always rises to the highest point, thereby confining the oxygen to the lower pelvis and reducing the pressure against the diaphragm. If the deflation method is not used, the absorption of the gas within the abdominal cavity varies individually from several hours to a few days.

That there is some discomfort to patients we do not deny. However, we must refuse to accept as contraindicative to the method the slipshod application of it by physicians who are either too indifferent or too inexperienced to follow the technic carefully.

DEFLATION

Of late, we have employed an extremely simple method to relieve the patient of any real or imaginary pain which might be connected with the procedure. It is simply to deflate the abdomen after the roentgen-ray examination has been completed. After the patient has been brought back to bed, the lumbar puncture needle is reinserted in the same manner as before, and the air is allowed to pass out through the needle. This eliminates any possible discomfort to the patient, and adds distinctly to the simplicity of the method. We have employed this procedure in all of our cases, to the full satisfaction of the patients and ourselves, since Feb. 16, 1920. Tierney [5] has adopted a similar procedure.

The need of careful technic with the adoption of strict aseptic precautions is illustrated by Hyman's [6] observation of a low grade peritonitis among his first patients. We have had no similar experience, and in conformity with others who are utilizing the procedure we consider it entirely safe and devoid of danger when properly employed.

5. Tierney, J. L.: Pneumoperitoneum, J. Missouri M. A. 17: 137 (April) 1920.
6. Hyman, A. S.: Radiography in Artificial Pneumoperitoneum, Med. Rec. 97: 100 (Jan. 17) 1920.

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ADVANTAGES OF PNEUMOPERITONEUM

The esential feature of the new method, aside from the introduction of a contrasting agent in the form of air or gas, consists in the resulting change in the position of the viscera in the distended abdominal cavity, the mass of intestinal coils in particular, which interfere with free inspection, being permitted to slip away as far as possible, regardless of whether the patient stands or is recumbent.

This method of gas inflation of the abdominal cavity enables us at the present time to show all the parenchymatous organs which heretofore have not been rendered visible or plainly brought out on the roentgenogram. We have shown the liver and, in many instances, pathologic enlargements and deformities of the gallbladder, and in several cases gallstones. We believe, however, that even with the aid of oxygen inflation, it is difficult to detect many cases of cholelithiasis, especially when the gallstones are of the same density as the surrounding tissues.

The different varieties of splenic enlargement have been beautifully shown. The diaphragm and subdiaphragmatic spaces have been clearly outlined. In many instances we were able to bring out the details of enlarged mesenteric glands, and in one or two cases the branches of the mesenteric artery were demonstrated.

Cysts of the liver, prancreas and ovaries have been clearly shown, and malignancies involving the large and small intestine easily detected. The female genital organs in their entirety, including tumors of those organs, have been visualized.

Probably one of the most beautiful reproductions is the renal outline. Pneumoperitoneum, when used in conjunction with pyelography, accurately outlines the renal pelves and calices, and at the same time shows with detail the renal structure, its enlargements and deformities.

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Changes of the vertebral column are also much more clearly revealed by this method than by the ordinary one. One of the most valuable findings has been the actual demonstration of adhesions. With special reference to adhesions, postoperative or the result of chronic inflammatory processes, we are inclined to believe, on the basis of personal findings, that their existence involves no serious danger of perforating the intestine. The clinical material at Harlem Hospital is rather abundant in this respect, and our list includes patients who have undergone three or even four laparotomies.

CONTRAINDICATIONS

As to actual contraindications, the existence of acute abdominal conditions, such as acute appendicitis or peritonitis, naturally prohibits the employment of the method of abdominal inflation. Nor should this procedure be carried out in known cases of valvular disease of the heart, for more work is required of this organ when the abdomen is inflated than under ordinary conditions. Our experience has shown that a certain type of elderly persons, notably men who have used alcohol in excess, does not readily lend itself to the employment of this method. On the other hand, the average man, woman or child is a perfectly satisfactory subject and with the adoption of the deflation method described above, which will naturally follow as the method enters into more general practice, the performance of entirely painless inflations will soon become the rule.

INDICATIONS

The indications for air inflation of the abdomen in connection with roentgenology have been slowly but considerably extended on the basis of growing experience as regards the harmlessness of the method and its wide sphere of usefulness. Entirely new vistas have undoubtedly been opened up, and when the method is

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demonstrated it never fails to convey the impression of a new and promising domain in diagnosis. At its present stage of development, however, the method should be reserved for the elucidation of diagnostic problems which have so far baffled the ingenuity of the clinician. The roentgen-ray examination will in some of these cases reveal a distinctly surgical situation demanding operative interference for its relief. In other instances many futile, inefficient or actually harmful operations will be abandoned on reception of the illuminating information furnished by the roentgen ray.

The method should not be employed indiscriminately. Its application should be reserved for suitable cases in which great advantage is seen to attend its adoption. All new methods fall heir to the common fate of being held responsible for all accidents and untoward occurrences due to lack of practical experience. In trained hands and with the employment of proper technic, there is every reason to anticipate the most gratifying results from this new adjuvant to abdominal diagnosis.[7]

48 East Seventy-Fourth Street—222 West Seventy-Ninth Street.

7. In addition to the references already given the following will be found of interest:

Alessandrini, P.: Pneumoperitoneum for Radiologic Work, Policlinico (sez. prat.) **26**: 641 (May 25) 1919.

Dandy, W. E.: Pneumoperitoneum **70**: 378 (Sept.) 1919.

Goetze, O.: Pneumoperitoneale Roentgendiagnostik, Deutsche med. Wchnschr. **45**: 491 (May 1) 1919.

Mallet, Lucien, and Baud, Henri: Injections of Oxygen to Aid Roentgenography, Progrès méd. **34**: 507 (Dec. 20) 1919.

Orndoff, B. H.: Pneumoperitoneum in X-Ray Diagnosis, J. Roentgenol. **2**: 265 (Sept.) 1919; Pneumoperitoneum, Surg., Gynec. & Obst. **30**: 386 (April) 1920.

Ribadeau-Dumas, L.: Mallet, and de Laulerie: Bull. Soc. med. d. Hôp. **43**: 952 (Nov. 13) 1919. (Short description of the method without any illustrations.)

Rosenblatt, Joseph: Pneumoperitoneum—Roentgenological Findings and a Few Observations on Intra-Abdominal Pressure, New York M. J. **110**: 501 (Sept. 20) 1919.

Schittenhelm, A.: Ueber die Roentgendiagnostik mit Hilfe künstlicher Gesansammlung in der Bauchhöhle, Deutsche med. Wchnschr. **45**: 566 (May 22) 1919.

Von Teubern: Ehfahrungen mit dem Pneumoperitoneum in der ambulanten Praxis, Deutsche med. Wchnschr., 1919, No. 45.

Weil and Loiseleur: Injection of Air for Radioscopy, Bull. Soc. méd. d. Hôp. (Dec. 12) 1919.

Whitman, Armitage: Oxygen Inflation of the Peritoneal Cavity, J. A. M. A. **74**: 1021 (April 10) 1920. Reply by Stewart, W. H., and Stein, Arthur, ibid. **74**: 1271 (May 1) 1920.

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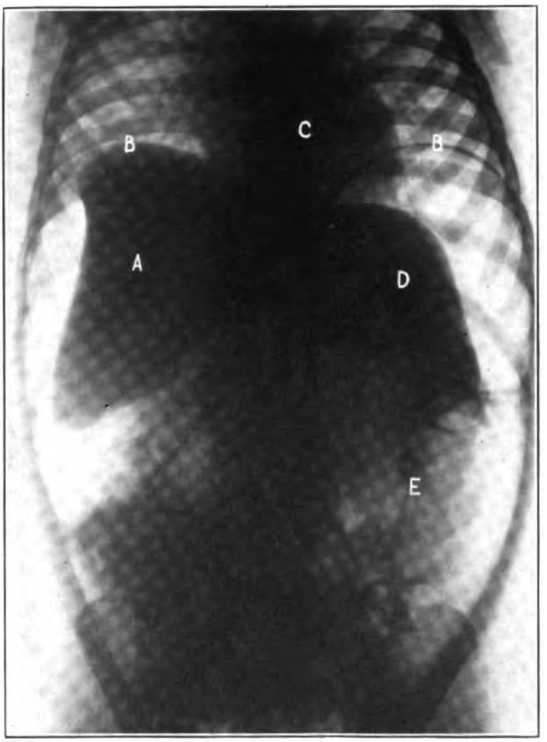

Fig. 1 (patient referred by Dr. J. F. Connors).—Details of the abdominal organs in a child, aged 7 years: *A*, liver; *B*, *B*, diaphragms; *C*, heart; *D*, spleen; *E*, coils of small intestine.

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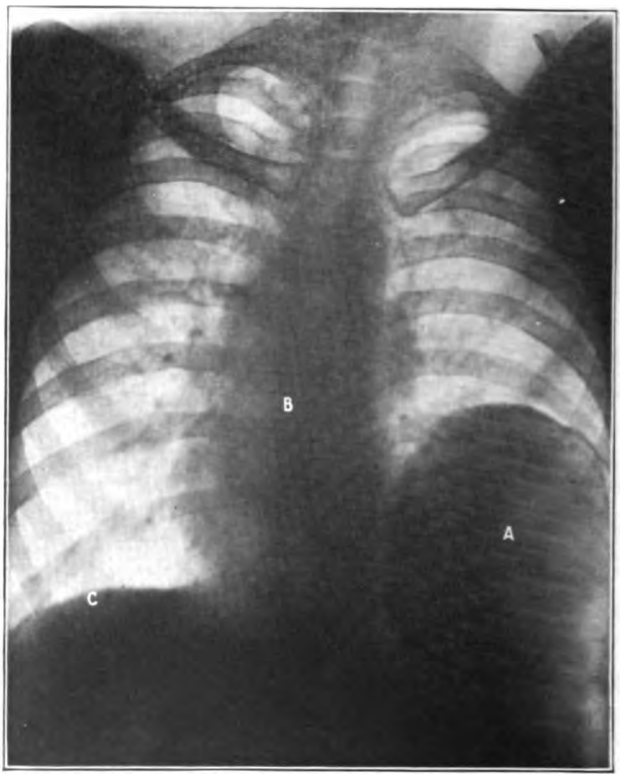

Fig. 2 (patient referred by Dr. Willy Meyer).—This roentgenogram, taken without oxygen inflation, shows a circular tumor in the lower portion of left chest. Question: Is the diaphragm above or below the tumor? *A*, tumor; *B*, heart; *C*, right diaphragm.

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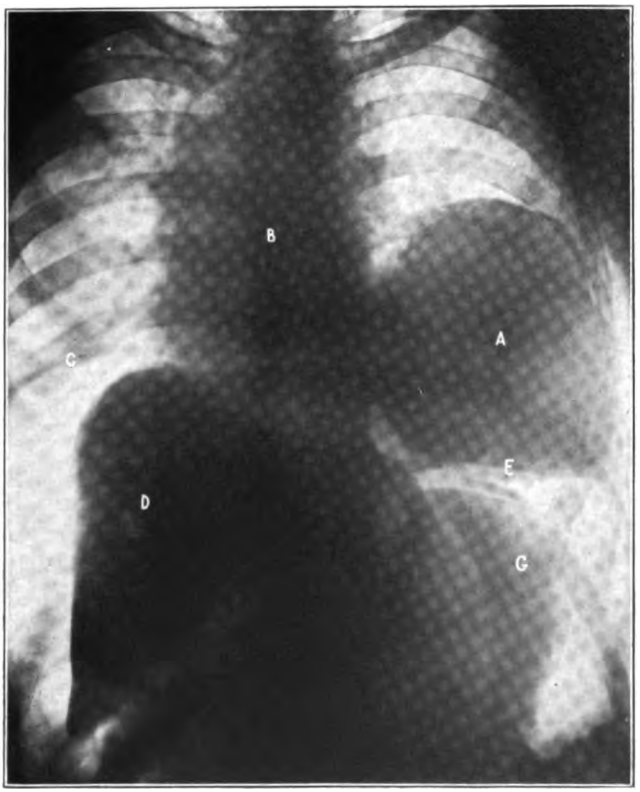

Fig. 3 (same patient as in Figure 2, inflated with oxygen).—Diaphragm is below the tumor. Roentgen diagnosis, cyst of lung: operative diagnosis, tuberculous cyst of lung. *A*, tumor; *B*, heart; *C*, right diaphragm; *D*, liver; *E*, left diaphragm; *G*, spleen.

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Fig. 4 (patient referred by Dr. Willy Meyer).—Cyst of liver, proved at operation to be echinococcus cyst: *A*, liver; *B*, cyst; *C*, stomach filled with barium; *D*, oxygen; *E*, descending colon.

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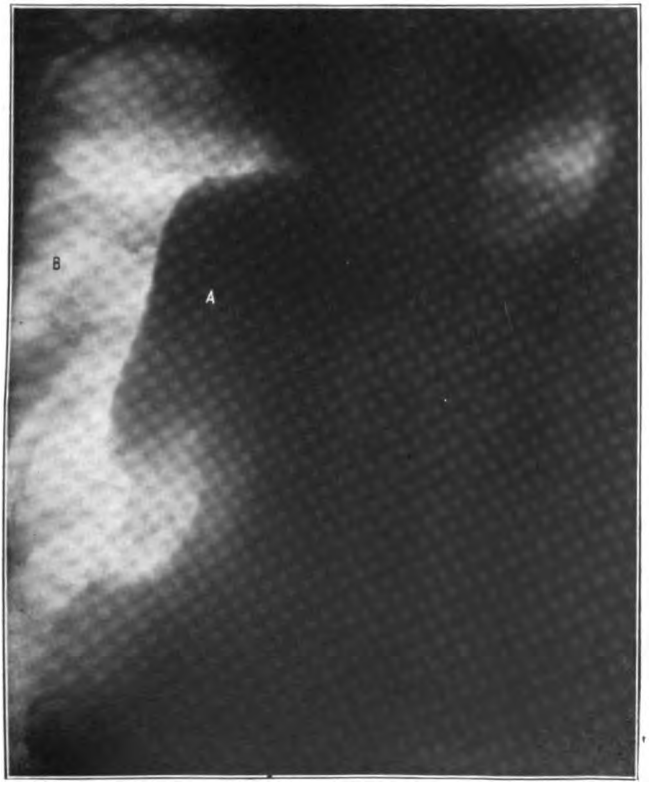

Fig. 5 (patient referred by Dr. Jacob Kaufmann).—Atrophic cirrhosis of liver; *A*, small, contracted liver; *B*, oxygen.

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Fig. 6 (patient referred by Dr. Jacob Kaufmann).—Splenomegalia: *A*, enlarged spleen; *B*, liver; *C*, right kidney; *D*, left kidney; *E*, transverse colon filled with barium.

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Fig. 7 (patient referred by Drs. Max Einhorn and Frederick Kammerer).—Roentgen diagnosis, tumor behind stomach: operative diagnosis, retroperitoneal tumor, probably glandular; inoperable. *A*, tumor; *B*, left kidney; *C*, spleen; *D*, liver; *E*, coils of intestine.

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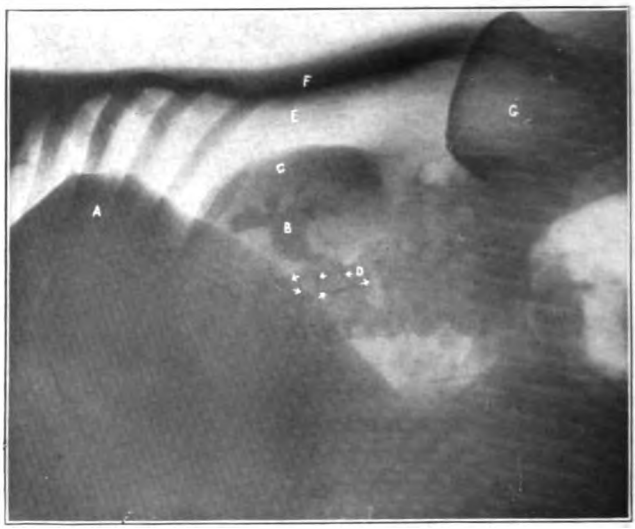

Fig. 8 (patient referred to us by Dr. F. J. Echeverria). Enlarged kidney; hydronephrosis from kinked ureter (patient in lateral position): *A*, liver; *B*, renal pelvis injected with thorium; *C*, outline of enlarged kidney; *D*, kink in ureter; *E*, oxygen; *F*, lateral abdominal wall; *G*, right ilium.

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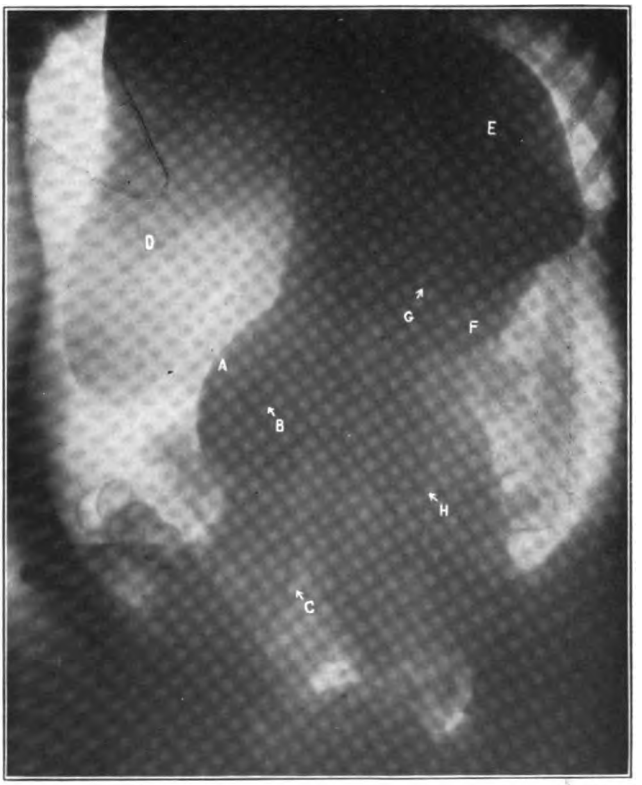

Fig. 9 (patient referred by Dr. F. J. Echeverria).—Prolapse of right kidney with rotation: *A*, prolapsed and rotated kidney; *B*, right renal pelvis injected with thorium; *C*, opaque catheter in right ureter; *D*, liver; *E*, spleen; *F*, left kidney; *G*, left renal pelvis injected with thorium; *H*, left ureter.

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Fig. 10 (patient from Dr. A. Stein's service).—Postoperative adhesions: *A*, anterior abdominal wall; *B*, oxygen; *C*, adhesions.

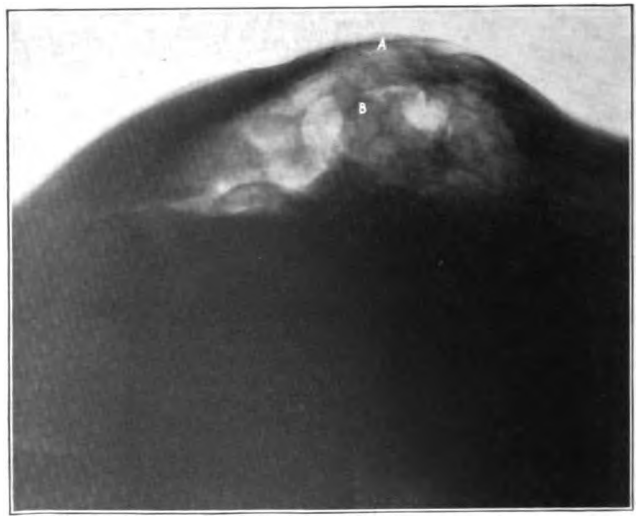

Fig. 11 (patient referred by Dr. I. S. Haynes).—Marked adhesions in large ventral hernia: *A*, thinned abdominal wall; *B*, intraperitoneal adhesions.

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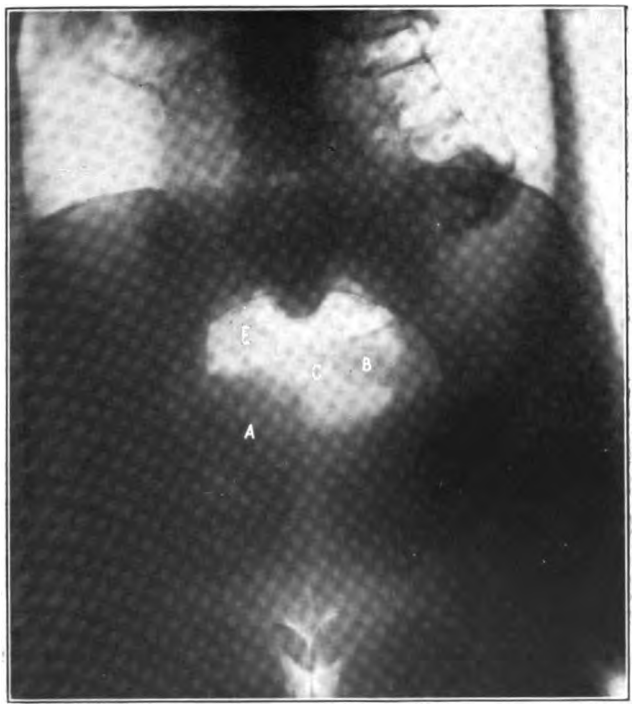

Fig. 12 (patient from Dr. A. Stein's service.)—*A*, uterus; *B*, tumor of ovary; *C*, adhesions between uterus and ovary and between ovary and pelvic wall. Operative findings: cyst of ovary the size of a walnut; omental adhesions between uterus and ovary and between ovary and pelvic wall.

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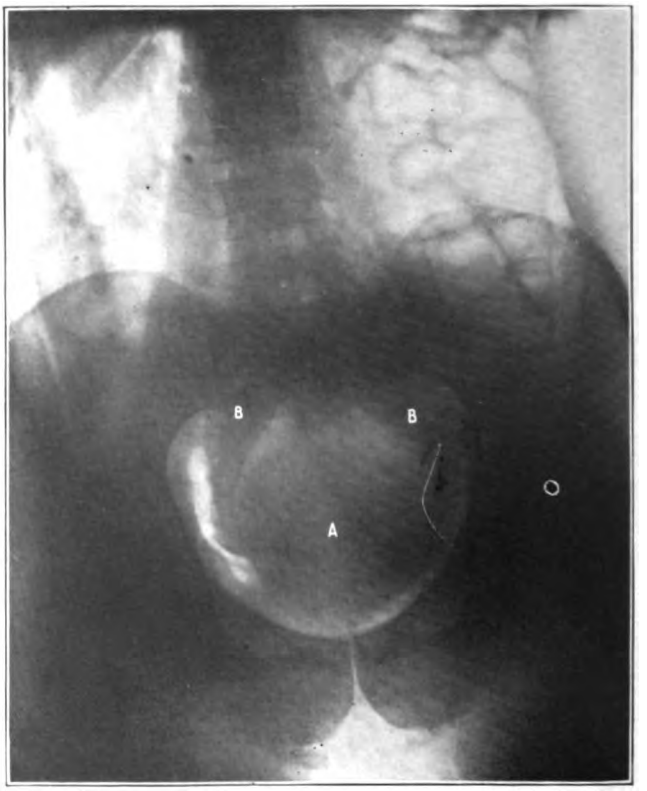

Fig. 13 (patient from Dr. A. Stein's service).—Uterine myoma with double (old) pyosalpinx: *A*, large myomatous uterus; *B*, right and left pyosalpinx (roentgen-ray diagnosis confirmed at operation).

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ABSTRACT OF DISCUSSION

DR. GEORGE E. PFAHLER, Philadelphia: In practically all instances we can demonstrate the lower border, sides and general outline of the spleen and liver by ordinary fluoroscopy or by plate methods. But the pneumoperitoneal method is of a distinct advantage in demonstrating irregularities on the lower border of the liver, or on the right border of the spleen. Its great advantage is in differentiating these dense shadows in the lower part of the chest from the solid tissues in the abdomen, the liver or the spleen; also, in outlining any solid tumor, enlarged glands or adhesions within the abdomen. It seems to be safe. When we have once eliminated the possibility of filling defects in the gastro-intestinal tract, and still must determine the pathology within the abdomen, this method is of distinct advantage. What is done with the needle during the time that the patient is lying on the abdomen, and how is the air withdrawn from the abdomen later?

DR. B. H. ORNDOFF, Chicago: I wish to draw attention to five points: (1) Pneumoperitoneum is of the greatest value when used in the preparation of a patient for further diagnostic investigation. (2) Having produced pneumoperitoneum more than four hundred times myself in connection with various pathologic conditions and without having a case where reaction of a serious character has been noted as the result of it, I am thoroughly convinced that when care is observed with regard to the technic of administration, it is a comparatively safe procedure. (3) Pneumoperitoneum may be produced for therapeutic purposes, such as tuberculous peritonitis and other inflammatory conditions of the peritoneum, for the relief and prevention of peritoneal adhesions and in conjunction with radiotherapy, etc. (4) For diagnostic purposes, pneumoperitoneum facilitates greatly the study of the abdominal viscera by means of the roentgen-rays. (5) The necessity for special equipment designed to meet the requirements of a careful and complete study of the abdominal organs after pneumoperitoneum has been produced.

DR. WILLIAM H. STEWART, New York: Dr. Pfahler mentioned the importance of this method of diagnosis only in those cases in which the information cannot be obtained by ordinary means. This point cannot be emphasized too strongly. By deflation we mean a reinsertion of the needle, after the roentgen-ray examination has been completed, for the purpose of drawing off the gas from the peritoneal cavity. The needle is not left in situ after inflation on account of the damage that might be done to the viscera during the change of posture necessary in making the roentgen-ray examination. Deflation relieves the tension and pain when present to such an extent that we now have

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hopes of making the method an office procedure. We still insist that simplicity of the apparatus is essential. Dr. Rothenberg, one of the very early workers with this method, has now discarded filtration or sterilization of the gas as well as the use of any apparatus for measuring the pressure. If one has the proper surgical experience there will be no difficulty in reaching the peritoneal cavity; we have never felt the necessity of injecting salt solution to ascertain this fact. Our successful examination of eighty cases, without a fatality occurring, is largely due to the simplicity of the method.

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ETHER-OIL COLONIC ANESTHESIA

WALTER LATHROP, M.D.
HAZLETON, PA.

Experience with the method here described is presented from the standpoint of the operating surgeon, and has been derived from 1,002 cases of various kinds, chiefly goiter, thus distributed:

Hyperthyroidism and exophthalmia	166
Cystic goiter	104
Colloid and cystic goiter	388
Parenchymatous goiter	226
Abdominal and miscellaneous	118
Total	1,002

In 1902, Cunningham, at the Boston City Hospital, devised an apparatus for introducing ether-laden air, which was used in that institution, without causing the complications of earlier methods. This ether and air, however, caused colicky pains and discomfort. The same conditions were found by Buxton, who observed, in addition, tenesmus, diarrhea and more or less collapse. Many other reports were made by various observers, but they were largely negative, until the first marked advance was made by Sutton,[1] using oxygen instead of air with ether. He reported 140 cases in the Roosevelt Hospital, New York City, chiefly in the service of George E. Brewer, but the apparatus used was rather complicated, and this method was again allowed to lapse.

Hewitt[2] says, "If the risk of diarrhea, melena, and after stupor could in any way be greatly reduced, rectal etherization would be strongly indicated in certain

1. Sutton, in Gwathmey and Baskerville: Anesthesia, New York, D. Appleton & Co., Chapter XI.
2. Hewitt, F. W.: Anesthetics and Their Administration, New York, the Macmillan Company, 1912.

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cases." This has been accomplished by the present method of combining ether and oil.

Dr. James T. Gwathmey made the first report on experimental work, before the International Medical Congress, London, in 1913. In 1915 he published a very complete paper[3] on colonic anesthesia, giving its early history, experiments of various kinds, and the different technic used by those who had tried this method of inducing anesthesia. That paper still stands as a complete record and reference, worthy of being read by all who may be interested in this subject.

In cooperation with Gwathmey, experiments were made by Dr. Charles Baskerville, professor of chemistry in the College of the City of New York, and Dr. George Barclay Wallace, professor of pharmacology, University and Bellevue Hospital Medical College, to determine the rate of evaporation of ether from oils, and tests were made with vegetable, animal and mineral oils, such as olive, cotton seed, peanut and soy bean, cod liver, lanolin and liquid petrolatum. The ether used was free from acids, aldehyds and water. The experiments were made in glass, and, while not showing the changes that would take place when the ether and oil come in contact with the walls of the colon, on account of diffusion and osmosis, yet some facts were well demonstrated.

1. While ether boils at 34.6 C., it does not escape violently from an oil-ether mixture, as from an aqueous mixture when heated higher, nearly to 37 C., or body temperature.

2. The rate of separation of ether from oil quickly acquires a definite and fairly fixed speed.[4] This rate of separation is important, as a proper content of ether may be maintained in the blood to produce a desired effect, as, for example, the surgical stage of

3. Gwathmey, J. T.: American Year Book of Anesthesia and Analgesia, 1915.
4. Baskerville: Am. J. Surg., January, 1916.

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anesthesia. Four factors, acting in harmony, help to maintain an even anesthesia:

1. The constant rate of evaporation of the ether from the oil.

2. The distention of the colon, causing less ether to be absorbed than when partially distended.

3. Cooling of the mixture and the intestine as the ether leaves the oil, which retards elimination and absorption.

4. The difference between the absorptive power of the colon and the eliminative capacity of the lungs. (Gwathmey).

Within five minutes after the injection of the mixture into the rectum, it is heated to body temperature; some ether leaves the oil in the form of gas, which is absorbed by the blood in the capillaries about the colon. The ether is carried through the liver by the greater circulation to the heart, and from there it is pumped into the lungs, where some of it is excreted by the air passages, while the remainder is reabsorbed, and carried on to the brain and central nervous system. The odor of ether and paraldehyd can be detected on the breath in from three to five minutes after the administration of the preliminary dose. The accumulation of mucus or saliva, seen often in inhalation anesthesia, is absent; there appears to be no irritation of the lungs, as only the ether required for narcosis passes through the respiratory tract, and the bronchial secretions, which are increased by local irritation under inhalation methods, are absent.

The respiration is normal, as a rule, and very seldom noisy or stertorous, if the anesthetist is watching the patient. The eye reflex is usually retained, even though good muscular relaxation is present. I have noticed analgesia in a number of cases, as also have others, and have conversed with the patient at different times during the operation; this is not to be expected very often. The pulse is maintained at an

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even plane; if rapid, as in hyperthyroidism, it usually remains so, though we frequently get a slowing, which is no doubt psychic. In ordinary cases the pulse remains full and strong. The blood pressure varies. In cases of great nervous tension, such as exophthalmia, observation has shown that the pressure falls after the patient is asleep, and usually rises immediately on his regaining consciousness. The diastolic pressure is usually low. Pressure in ordinary cases does not vary much, though the amount of surgical interference naturally has a decided effect. This applies to hemorrhage, and undue manipulation of viscera.

The safety of this method is shown by several factors, such as the rate of evaporation of ether from oil, in accordance with well known physical laws. The ether may be separated from the oil at any time by warming; but unless deliberately raised to a high point, it passes off slowly, especially at body temperature. After administering the mixture it is impossible to withdraw oil and leave ether, or vice versa. Each molecule of one is bound to a molecule of the other, and the union is broken only by evaporation. It is impossible to have deep anesthesia at one minute, and light anesthesia at another, unless purposely accomplished by rebreathing, or made light by an air-way tube or a face free from covering.

Sutton has shown that when the colon is fully distended, less ether is absorbed. When we recall that the absorbing surface of the colon is much less than that of the lungs, we see that some distention of the colon is necessary to increase its absorbing surface, and we know that overpressure does not take place, for there is very seldom distress after anesthesia, such as diarrhea, bloody stools or tenesmus, that was usual with the Cunningham-Sutton method. Again, when the ether leaves the oil as gas, the intestine is cooled during the process. This retards elimination and

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absorption, thus regulating the dose. The temperature of the patient remains constant, and the cold, clammy skin so often seen under inhalation anesthesia is absent in nearly all cases. The gradual absorption of the ether by the colon no doubt acts as an element of safety. Wallace made a study for one hour, by sphygmographic tracing, of a number of animals under ether-oil anesthesia, during which the pulse and respiratory tracings never varied. This fact has been well demonstrated in many hundreds of patients surgically anesthetized by this method, in whom, without any supplementary anesthetic, the pulse, respiration, reflexes and blood pressure all remained constant, except, as already mentioned, in hyperthyroidism.

The value of olive oil has been shown by Graham, who proved beyond question that this oil is capable of restoring to the blood certain properties which are inhibited by the action of the ether, that is, those concerned with phagocytosis. The injection of certain amounts of the oil into the rectum is followed, after three to six hours, by a restoration of phagocytic power, although ordinary depression lasts for some time. The oil absorbs any ether vapor that may still remain in the intestine, and not only prevents protracted undesired effects, but also insures speedier restoration of the opsonic index, and satisfactory recovery.

It is interesting to note that the experiments of Dr. W. H. Park of New York showed that an ether in oil mixture killed the colon bacillus in one minute, thus giving another factor of safety in the possible prevention of infection. Our experience has shown that the postoperative effects are better than with the routine inhalation methods of ether and chloroform, though there is no doubt about the great value of nitrous oxid and oxygen anesthesia.

After ether-oil anesthesia there is less vomiting or nausea, and the patient is usually comfortable and

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can retain nourishment; and of greater importance is the fact that there is considerable analgesia for some time, often for two or three hours, which adds to the ease of the patient.

Anociation as practiced by Crile can be carried out easily, and no doubt is very valuable in many conditions, especially exophthalmia and hyperthyroidism. Ether-oil anesthesia is especially useful in head and neck operations, because the operator is not troubled by either cone or anesthetist. It is also useful in hernias, especially as seen in patients with asthma, and in our work among coal workers, who have the common condition known as miners' asthma. These patients sleep calmly throughout, with none of the choking and cyanosis seen under ether by inhalation. The value of local anesthesia must not be forgotten in these conditions also.

Patients with short thick necks are especially good subjects for colonic anesthesia. The most valuable of all its uses is in those conditions of high nervous tension, such as hyperthyroidism, or in cases just on the border line of toxic goiter, and also when fear is a prominent factor, as seen in nervous women, and in men as well. To be able to etherize a patient in bed, remove her to the operating room, perform the operation and return her to bed with little or no knowledge of what has been done, is surely worthy of consideration, and trial in proper cases.

TECHNIC OF ADMINISTRATION

It is most important that the use of the mixture be in the hands of one who can begin its administration and have it under his care throughout and in all cases. It should never be delegated to a different physician or nurse each time it is used. The same care should be taken as in any other type of anesthesia. Experience is the great factor, and in our earlier work we used much more anesthetic than at present. After

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trying out various combinations and proportions, we settled down to the routine method to be described. The patient should be under observation for twenty-four hours or more. This does not apply to exophthalmic or hyperthyroid conditions, in which preliminary observation and treatment are imperative. The evening before operation an enema of soapsuds (2 pints) is given. A second enema of 1 or 2 pints of clear, tepid water is given early the next morning. To illustrate: Supposing the operation is set for 11 a. m.; then at 9:30, 2 drams of olive oil (warm), 3 drams of paraldehyd and 4 drams of ether, are given. The patient should be kept as quiet as possible. At 9:50, ¼ grain of morphin and $\frac{1}{150}$ grain of atropin are given hypodermically. At 10:20, 3 or 4 ounces of ether and 2 ounces of olive oil (warm) are given. The oil and the ether are put in a bottle and shaken thoroughly. The patient should be on the left side with both knees flexed, the right acutely. A rectal or colon tube with a funnel should be inserted not more than 6 inches, care being taken to have the mixture in the tube and all air expelled, before inserting. The mouth and nose should be covered with several thicknesses of gauze. The injection should be given slowly, *about one ounce a minute,* the funnel being held about 3 inches above the level of the patient. The tube should be clamped and allowed to remain in the rectum so that the mixture may be withdrawn during operation if there should be any indication for doing so. If there is any excitement, 15 or 20 drops of chloroform usually quiets the patient. If the patient cannot retain the oil-ether mixture, one should not try to repeat, but abandon it. The patient should be ready for operation in from twenty to thirty minutes from the time the last injection is given. The reversed Trendelenburg position seems to aid in the maintaining of an even plane of anesthesia. The jaw should be supported so that respiration will be unobstructed.

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In alcoholic subjects, 1/100 grain of scopolamin (hyoscin) is added to the preliminary hypodermic injection of morphin. When the operation is completed, the bowel should be well irrigated with tepid water until it returns clear. The colon may be gently massaged from right to left to aid this. One pint of water is then put in the bowel and left, or olive oil may be given in quantity of 4 ounces, to prevent any possible irritation that may be feared, though in more than a thousand cases we have had only two instances of irritation, both being an annoying looseness, which speedily yielded to treatment.

Hyperthyroidism or exophthalmia offers a most striking condition in which the value of this method is shown. These patients, as is well known, are usually high strung, nervous and apprehensive, while the danger itself is by no means small. We have repeatedly operated, with little or no knowledge on the part of the patient; stealing the gland has indeed been easy. The procedure with these patients is as follows: Supposing operation is decided on for Saturday, then a week previous, we give each day an injection of 2 ounces of tap water, with a dram of ether in it. This, the patient is told, is for its tonic effect. The morning of operation she is given the regular dose of ether-oil and paraldehyd followed by hypodermic, and the full mixture, all given while she is in bed. She usually goes to sleep very quietly, though at times requiring a few drops of chloroform; is taken to the operation room, the gland removed, or ligation performed, and when she awakens, she is in her bed, with little knowledge of what has taken place, aside from knowing something has been done to her throat; but the fear is greatly lessened or gone.

COMMENT

Surely this is well worth trying in such conditions, and when supplemented by Crile's nerve blocking, is

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an ideal means to get results in a very bad class of cases.

Mr. Wade[5] of London, anesthetist to the Queen's Hospital, says: "There is no doubt that this is a very valuable method of anesthesia for many operations in plastic surgery."

Ether-oil colonic anesthesia is *contraindicated* in *conditions of rectal disease,* or when *pain is caused* by its introduction. It is not recommended for routine use, as the time required for successful administration would not permit of this method, especially when a number of operations were scheduled. For regular clinic work we depend on ether by inhalation, reserving colonic anesthesia for the class of patients already mentioned. When successfully used, it will not be given up by the surgeon who tries it. Dr. Arrowsmith of Brooklyn has shown the value of this method in bronchoscopy and in gastroscopy, in which the absence of excess mucus in the air passages is a most valuable factor, as is also the fact that there is a clear passage for the escape of ether vapor. The value is undoubted in cases in which absorption must be minimized on account of some lung, heart or kidney lesion.

Our experience with this method for children has been very small, and has not been satisfactory, owing chiefly to the lack of cooperation on the part of the child, and the expelling of the mixture.

To sum up, we would advocate ether-oil colonic anesthesia in the type of cases mentioned, and emphasize the safety, comfort, control, efficieny and simplicity of the method. Under efficiency, we can do no better than quote Gwathmey, whose conclusions are practically in accord with our own:

> The method insures prevention of shock, narcosis is smooth and of uniform depth, pulse and respiration remain near normal. A complete relaxation of the muscular system is secured. The stage of excitement is eliminated. The patient inhales a warm, moist vapor, and the direct irritation of a

5. Wade: Anesthetic Supplement, Am. J. Surg., July, 1919.

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concentrated vapor is overcome. There is no eructation of gas, before or after, in 95 per cent. of cases. Hypersecretion of mucus and saliva is absent. The patient's stomach, lungs and kidneys are spared. The absence of the ether cone in surgery of the head and neck lessens the technical difficulties of the operation by giving continuous access to the field of operation.

Postoperative nausea and gas pains are reduced to a minimum.

State Hospital.

ABSTRACT OF DISCUSSION

DR. JAMES T. GWATHMEY, New York: Certain fundamental principles should be emphasized: When physiologically understood, ether-oil colonic anesthesia is one of the easiest methods to administer, requiring only a rectal tube with funnel attached and quiet for the patient. It is one of the safest methods. The margin between full surgical anesthesia and a toxic dose is greater than with any inhalation method. It is one of the most pleasant methods for the patient, as attested by the fact that those who have tried other methods prefer the colonic. A greater relaxation of the musculature exists than is usual with any inhalation anesthetic. A smaller amount of ether per hour is required than by any other method. The estimated amount is two ounces per hour, which seldom varies. It is regulated as easily as any inhalation method, by (*a*) covering the face with a towel to deepen the anesthesia, (*b*) by placing an airway tube to lighten, or (*c*) by unclamping the rectal tube and draining the residue, and flushing thoroughly. It can be terminated at any time, as far as the anesthetic is concerned, the patient continuing to sleep from the other drugs used. While the rate of absorption is slightly different with each patient, dependent on the age, temperature and general condition, it is constant when established—an anesthesia deep at one time and light at another is physiologically impossible. The brain is more completely protected against reflex stimuli than by any method of inhalation anesthesia; and this is proved by the patient crossing his legs, changing his position, or conversing with the surgeon as in spinal analgesia. So-called analgesia with nitrous oxid-oxygen, where the patient is continually squirming and refusing to be comforted by the anesthetist, but on awakening, remembers nothing of the pain, is not analgesia but amnesia. The brain is not protected in so-called analgesia with nitrous oxid and oxygen. The complete analgesia of the colonic method is dependent on the synergistic action of all the drugs concurrently given with the ether—an extra amount of ether will not have the same effect. The quiet sleep and analgesic

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stage for a few hours after the anesthetic is terminated is an advantage to the patient, and should not be counted against the method.

Dr. Alexander Primrose, Toronto: In the hospital at Sidcup, England, Major Gillies found that rectal anesthesia by ether oil was entirely satisfactory. In these cases requiring a prolonged technic for the repair of face and jaw wounds, it was important to get the anesthetist out of the way of the operator.

Dr. J. Shelton Horsley, Richmond, Va.: When a cautery must be used in the mouth colonic anesthesia is ideal. It would seem indicated in cases of exophthalmic goiter, but here, in my hands, the results have been unsatisfactory, probably because this disease causes some affection of the liver, as Dr. Crile has shown. If you pour all the ether through the portal circulation and concentrate it on the crippled liver there may be unfortunate results. It is like giving ether by inhalation to a patient with seriously damaged lungs.

Dr. George W. Crile, Cleveland: Do you use local anesthesia in conjunction with local analgesia?

Dr. Walter Lathrop, Hazleton, Pa.: Yes. Our best success has been with the exophthalmic type of goiter. We have had very few mortalities, not more than we would have had with any other method because we know what hyperthyroidism means. We get these patients in the best condition possible. If we are going to operate a week from today on a woman highly strung, nervous, scared to death, she is given a dram of ether and two ounces of tap water as a "tonic." This is repeated daily until the seventh day, when she is given the regular dose of paraldehyd, ether and oil followed by a hypodermic. She wakes up in bed after the operation with little knowledge of what has been done.

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IMPORTANCE OF THE VITAL CAPACITY IN THORACIC SURGERY *

EVARTS A. GRAHAM, M.D.
ST. LOUIS

The act of inspiration consists of an enlargement of the thorax with a resultant inrush of air down the trachea and into the lungs in order to equalize the pressures of the air outside the body and inside the lungs. The act of expiration, on the contrary, is accomplished by a diminution of the thorax, which in turn forces the air out of the lungs. The amount of air, therefore, which is taken in and given out with each act of respiration, under normal conditions, is regulated almost entirely by the extent to which the thorax enlarges itself. The limit of possible enlargement is determined by a number of factors, important ones of which are the size of the individual, the flexibility of the thorax and the strength of the respiratory muscles. Hence it is evident that even so-called normal individuals may differ widely in their ability to enlarge their thoraces, and that those who have particularly strong respiratory muscles, athletes, for example, will show a greater ability to enlarge the thorax than other individuals of the same size who have poorly developed respiratory muscles.

John Hutchinson,[1] in 1846, published direct measurements which he had made on a large number of people, by means of his spirometer, of the amount of air which is inspired in ordinary respiration, and of the amount which is given out in the greatest possible

* From the Department of Surgery, Washington University Medical School.

1. Hutchinson, John: On the Capacity of the Lungs and on the Respiratory Functions, Med. Chir. Tr., London **29**: 137, 1846.

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expiration after the greatest possible inspiration. The former he called the "tidal air," and the latter the "vital capacity." The value of the vital capacity in the normal subject is very much greater than that of the tidal air. The difference is made up by the "complemental air," which is the additional amount that can be inhaled after an ordinary tidal inspiration, and the "supplemental air," which is the additional amount that can be exhaled after an ordinary expiration. Even after the supplemental air has been exhaled, there is still a considerable amount of air remaining in the lungs which is usually called the "residual air." The average values of these different volumes of air have been generally considered to be about as follows: the tidal air, 500 c.c.; the complemental air, 1,500 c.c.; the supplemental air, 1,500 c.c.; the vital capacity, 3,500 c.c.; the residual air, 1,500 c.c. More recently, especially through the work of Peabody and Wentworth [2] and of Dreyer,[3] it has been found that the generally accepted value of about 3,500 c.c. for the average vital capacity is very often greatly exceeded, and that men in general show a considerably higher value than women. Thus, the average in normal men of from 5 feet, 8½ inches to 6 feet in height was found by Peabody and Wentworth to be 4,800 c.c.; and one man, 6 feet, 3½ inches tall, had a value of 7,180 c.c. The average vital capacity in normal women over 5 feet, 6 inches in height was only 3,275 c.c.

Bearing in mind that the vital capacity represents in reality the greatest possible volume of air that one can voluntarily take into his lungs in addition to the already present residual air, it is evident that a determination of it in a particular case will afford a fairly accurate index of that individual's ability to compensate for any encroachment on his breathing surface.

2. Peabody, F. W., and Wentworth, J. A.: The Vital Capacity of the Lungs and Its Relation to Dyspnea, Arch. Int. Med. 20: 443 (Sept.) 1917.

3. Dreyer, G.: The Normal Vital Capacity in Man and Its Relation to the Size of the Body, Lancet 2: 227 (Aug. 9) 1919.

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That is to say, an individual whose tidal air is only one third or one fourth of his vital capacity will have less margin of safety if his breathing surface is further diminished than one whose tidal air is only one seventh or one eighth of his vital capacity. The reason for this is that the inflation of the lungs is chiefly a purely passive occurrence because of the fact that with an expansion of the thorax, as in the act of inspiration, the pressure within the pleural cavities becomes increasingly less than that of the atmosphere, so that air from the outside rushes into the lungs to fill a partial vacuum. If negative pressure cannot be established, at least during some part of the inspiratory act, obviously the lungs cannot be inflated. The establishment of negative intrapleural pressure depends to a great extent on the ability to enlarge the thorax. This fact lends itself readily to experimental demonstration. For if an interference with respiration is suddenly created, the most frequent and characteristic response is an increase in the amplitude (or depth) of the respiratory movements, a type of reaction which represents a compensatory effort to diminish the intrapleural pressure to a greater extent in order to inflate the lungs. If, in spite of the maximum respiratory efforts, the individual is able to take in barely enough air to maintain life, it is clear that he will be unable to compensate for any further encroachment on his breathing surface. In other words, if his vital capacity is so low that it practically equals his tidal air, any further interference with respiration, even if very slight, will almost surely result in death from asphyxia.

These considerations have a very important bearing on the treatment of empyema particularly, and also on thoracic surgery in general. In acute empyema, especially of the streptococcus type, one of the striking clinical features during the early stages is a marked dyspnea and cyanosis. In other words, these patients are already having so much difficulty in obtaining

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enough air to maintain life that their vital capacities approach their tidal air requirements. Obviously, therefore, their abilities to compensate for any further encroachment on their breathing surfaces will be exceedingly limited. For this reason alone, therefore, the addition of any factor likely to embarrass respiration still more, as the creation of an open pneumothorax to establish drainage, should be carefully avoided. There has been a commonly expressed feeling, however, that, because in some cases the exudate is large in amount, the lung on that side is already "collapsed," and that the creation of an open pneumothorax will cause little if any further harm. This feeling exists largely because of the prevalent conceptions that the mediastinum constitutes a more or less rigid partition between the two pleural cavities so that it is possible for one lung to be completely collapsed with maintenance of respiration only with the other lung.

It is possible, however, to show by direct experiment the incorrectness of the prevalent conceptions of the mechanism of open pneumothorax. During the summer of 1918, the writer,[4] in conjunction with R. D. Bell, while we were members of the Empyema Commission appointed by the Surgeon General, carried out experiments which seem to have an important bearing on this whole question. For the details the original article should be consulted. Briefly, these experiments showed that, contrary to the usual belief, the normal thorax from the standpoint of pressure relationships is practically one cavity instead of two. The normal mediastinum, in reality, offers so little resistance to changes in pressure that any alteration in pressure in one pleural cavity is accompanied by an alteration of practically the same amount in the other pleural cavity. For example, if air is forced into one pleural cavity in

4. Graham, E. A., and Bell, R. D.: Open Pneumothorax: Its Relation to the Treatment of Empyema, Am. J. M. Sc. **156**: 839 (Dec.) 1918.

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even so small an amount that a pressure is established equivalent to that exerted by a column of water only 10 cm. high, the pressure in the opposite pleural cavity will vary between that of 9 cm. and 9.5 cm. of water. In other words, the resistance offered by the mediastinum to even so slight a change of pressure is equivalent to that exerted by only 1 cm. or 0.5 cm. of water (0.4 mm. or 0.8 mm. of mercury); and it is therefore negligible. There is no noticeable difference in this respect between the dog and the human being, and therefore experiments on intrapleural pressures conducted on the dog are directly applicable to man. It would seem to follow from this that the two lungs must be about equally compressed if the pressure in one pleural cavity is altered. Direct experiment again demonstrates that this conclusion is correct, for determinations of the relative densities (and therefore the relative degrees of compression) of the two lungs when one pleural cavity contains air at a pressure equivalent to 10 cm. of water are practically equal.

In the living dog, the type of response which occurs after the creation of an open pneumothorax is usually somewhat as follows: Immediately on the making of a moderately large pleural opening there is an increase of pressure to practically the same extent in the two pleural cavities. Whereas, before the opening is made both the inspiratory and expiratory pressures are entirely negative, immediately afterward the pressure rises so much that it is almost entirely positive; the indicators descend below the base line of atmospheric pressure only near the end of the inspiratory act. These changes are also coincidental with an effort on the part of the respiratory mechanism to compensate by making a greater effort to get air into the lungs, and accordingly there is a marked change in the respiratory movement. Usually this change is rather an increase in amplitude than an increase in rate. If the pleural opening is small enough to allow compensation,

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the intrapleural pressures will gradually diminish so that negative pressure will be reestablished. The negative pressure, however, is never restored so completely as to reach the level at which it was before the opening was made, provided the opening remains in communication with one pleural cavity. Instead of both the inspiratory and expiratory intrapleural pressures being negative, as in the normal state, the pressure at the height of expiration will be positive. The ability, therefore, to withstand an open pneumothorax is dependent on the ability to compensate by increasing the respiratory effort. If the opening is made sufficiently large, the animal will pass through a state of marked dyspnea and die of asphyxia within a few minutes, owing to his inability to compensate, no matter how great his respiratory effort; for if the opening is so large that, despite his maximal respiratory efforts, he is unable to establish a negative pressure in the pleural cavity, he will be unable to get air into his lungs; or if he is able to establish a slight negative pressure, he may be able to get a little air into his lungs, but not enough to maintain life.

The degree of asphyxia which will follow the creation of an open pneumothorax in a normal chest will therefore depend to a considerable extent on the ratio of the amount of air which enters the thoracic opening to the amount which enters the lungs at each inspiration. It is possible to show this relationship by means of the following mathematical expression, in which, as will be seen, the vital capacity is an important factor:

$$X = \frac{V - \frac{R_1}{R_2} T}{\frac{R_1}{R_2} T} aC$$

V, vital capacity.
R_1, rate of respiration before the opening is made.
R_2, rate of respiration after the opening is made.
T, tidal air (approximately 500 c.c.).
a, a factor less than 1 (assumed to be 0.8).
C, area of the glottis (about 2.25 sq.cm.).

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If in substituting numerical values in the equation we insert 4,800 for V (the normal vital capacity of men with a height of from 5 feet, 8½ inches to 6 feet, according to Peabody and Wentworth [3]), 15 for R_1 (an average rate of respiration during complete rest) and 60 for R_2 (an estimated maximum rate for the greatest possible depth of respiration), then

$$X = \frac{4{,}800 - 125}{125} eC = 37.4 \times 1.8, \text{ or}$$

$$X = 67.32 \text{ sq.cm., or } 10.4 \text{ sq. inches.}$$

In other words, therefore, a normal man of from 5 feet, 8½ inches to 6 feet in height theoretically should be able to withstand a thoracic opening of about 67 sq.cm., or 10 square inches, for as long a time as his respiratory muscles are able to maintain a maximum effort. This theoretical value harmonizes fairly closely with the findings during the war that wounds of the chest which were often of surprising magnitude did not necessarily result in death from asphyxia. Actually, of course, during operative procedures on the chest, openings which are apparently very large are in reality much smaller because of the presence in the incision of a lung that has been delivered out, gauze packs, the fingers of the operator, instruments, etc., all of which tend to plug the opening somewhat and thus reduce its size.

On the other hand, it is readily apparent that if the vital capacity is smaller or larger than the value used in the example given above, the maximum nonfatal opening will also be smaller or larger, respectively. During the acute pneumonic stage of an empyema the vital capacity is always low. I do not know of any actual observations on the vital capacity during a severe acute pneumonia, but it is obvious that if, in spite of a maximal respiratory effort, air hunger and extreme cyanosis persist, the vital capacity must be nearly as low as the tidal air requirement. It will follow also from the theoretical considerations already given that

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when such a condition is present, any opening, no matter how small, is likely to result in a fatal asphyxia. Recently a striking confirmation of the validity of the mathematical expression occurred.

A young man who gave a history of having had pneumonia in the early part of February, and in whom pus had been found by aspiration, March 4, was admitted to the hospital March 7. An aspiration which was performed then resulted in the withdrawal of about 300 c.c. of moderately thick pus which contained hemolytic streptococci. A question as to the existence of an active pneumonia induced us to postpone the operation for a few days. March 12, immediately before the operation, the vital capacity reading was 1,600 c.c. and the tidal air, 400 c.c. It was felt that by this time sufficiently firm adhesions would be present to circumscribe the abscess and to prevent a general pneumothorax on that side. A resection of the eighth rib in the right posterior axillary line was made under nitrous oxid and oxygen anesthesia, and 400 c.c. of pus escaped. Immediately after the escape of the pus an alarming dyspnea with labored breathing occurred which was promptly improved by plugging the opening. On releasing the plug of gauze the dyspnea recurred; and it was again improved by applying a firm pad of dressings over the opening after a large drainage tube and a Carrel tube had been hurriedly inserted into the wound. Although the dyspnea was improved after the opening had been covered, it persisted to an uncomfortable degree for several hours. On the second day a tracing of the wound was taken and its area was computed by means of an Amsler planimeter, which revealed an area of about 2.1 square inches. A computation of the maximum nonfatal opening which this man could have on the basis of his vital capacity of only 1,600 c.c. gave a value of 3.3. square inches. If stabilizing adhesions were not present, therefore, the operative opening of 2.1 square inches allowed him a margin of safety of only 1.2 square inches, and it is not surprising that severe dyspnea resulted. As further evidence that firm adhesions were not present at the time of operation is the fact that one week later the cavity measured 1,300 c.c., although at operation only 400 c.c. of pus escaped, an indication that probably the alarming dyspnea was the result of a more or less general pneumothorax.

If firm adhesions are present, however, or if the mediastinum has been made more or less rigid by induration from long-standing inflammation, as in the case of chronic empyema and in many cases of pulmonary tuberculosis, then a change of pressure in one pleural cavity may not affect the other pleural cavity

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to anything like the same degree as in a chest without adhesions.

The older prevalent conceptions of the mechanism of action of an open pneumothorax will not explain the phenomena which have just been discussed; for, on the basis of such conceptions, death from asphyxia would be impossible from a unilateral open pneumothorax. The worst that could happen would be collapse of the corresponding lung, and life could still be maintained by the other lung. Moreover, a bilateral open pneumothorax would always be practically immediately fatal. Direct experiment, however, shows that a bilateral open pneumothorax is not appreciably more dangerous than a unilateral one, provided the combined areas of the bilateral openings are not greater than that of the opening on the single side. Apparently the only explanation of such a finding is on the basis of the conceptions which have been developed above. The importance of the determination of the vital capacity as indicating approximately the maximum nonfatal opening of the chest wall in operative procedures which involve entering the pleural cavity is apparent. As has been already stated, however, the presence of adhesions and induration of the mediastinal pleura will diminish the danger by lessening the compressing effect on the opposite lung. Before establishing an open drainage in a case of empyema, it would seem to be a matter of prudence to calculate in advance the theoretical maximum nonfatal opening on the basis of a determination of the vital capacity. If adhesions are not well developed, this preliminary calculation may save lives by the avoidance of too large an opening. In our service this preliminary calculation is always made.

A reduction of the vital capacity in cases of empyema is apparently always to be expected. It is very difficult to obtain an accurate reading during the acute pneumonic stage, but in a recent series of nine cases of adults the average reading at the time of operation for

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the establishment of drainage was only 37 per cent. of what the normal should have been for those individuals based on the tables of Peabody and Wentworth of the normal vital capacities for people of different heights. The lowest reading at the time of operation was 27 per cent. of the normal, and the highest 62 per cent. Six of the cases showed a hemolytic streptococcus and three a hemolytic staphylococcus. Another case of actinomycotic empyema gave a vital capacity reading of 47 per cent. of the normal. It is interesting that the vital capacity shows only a very slight improvement, if any at all, during the first few days after the withdrawal of a considerable amount of exudate, an observation which has previously been made by Peabody and Wentworth. Slowly, however, as the cavity diminishes and as the patient's general condition improves the vital capacity increases. This increase, coincidental with a diminution in the size of the cavity, is illustrated in the following case:

A young woman who had pneumonia in January entered the hospital, February 15. She was dyspneic and cyanotic. A right pleural effusion was diagnosed, and an electrocardiograph tracing revealed a heart block which was diagnosed by Dr. Wilson as due probably to digitalis which the patient had been taking. An aspiration of the chest resulted in the withdrawal of 1,450 c.c. of thin purulent fluid which contained both hemolytic streptococci and staphylococci. By February 21 she had recovered from the heart block and was much less dyspneic and cyanotic. Her vital capacity was 1,000 c.c. An intercostal incision was made and 800 c.c. of pus removed. From then on the diminution of the cavity and the increase of the vital capacity were as given in the accompanying table.

COURSE OF DIMINUTION OF CAVITY AND INCREASE OF VITAL CAPACITY

Date	Capacity of Cavity C.c.	Vital Capacity C.c.	Tidal Air C.c.
February 24	260	1,250	300
March 3	90	1,750	300
March 28	60	1,950	...
April 17	25	2,300	300

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She was discharged practically well, April 17, with a cavity of which the capacity was only 25 c.c. and with a vital capacity of 2,300 c.c., which represented a gain of from 36 per cent. of the normal vital capacity for a woman of her height (5 feet, 4 inches) to one which was 82 per cent. She was treated continuously with surgical solution of chlorinated soda (Dakin's solution) from the time of the operation until the drain was removed, March 30, except for a period of a few days beginning about February 24 and ending March 1. The interruption was because of a small pulmonary fistula which developed but which healed spontaneously during the period of cessation of the irrigations. She also used "blowing bottles" beginning a few days after the operation.

Another use which we have made recently of the vital capacity is to show the permanent physiologic deformity which results from extensive thoracoplastic operations. These operations not only are accompanied by a high mortality, but they often fail in stopping the suppuration, the very purpose for which they were intended, even if the patient survives the operation. Moreover, in addition to the mutilating anatomic deformity, there is apparently a permanent diminution in the vital capacity. This permanent decrease in the vital capacity is a serious handicap to the patient because it means that if he ever acquires a condition which in itself lowers the vital capacity, his chances of recovery will be considerably decreased as compared with an individual who at the start had a normal vital capacity. Such conditions are, of course, pneumonia or any other pulmonary disease, an uncompensated heart lesion, etc. Obviously, therefore, these operations should be undertaken only as a very last resort. The excellent results which have been achieved in the army with even the chronic cases of empyema as a result of an intelligent and painstaking use of Dakin's solution indicate clearly that extensive thoracoplastic operations will be unnecessary in all but the most exceptional cases. The additional evidence that these operations impose a permanent physiologic handicap should act as a further deterring factor in the consideration of the use of these procedures. The effect of an

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operation of the type of the Estlander-Schede is shown in the following brief report of a case:

A trained nurse, aged 28, presented herself, April 8, because of a discharging fistula in the left side of the chest at about the level of the ninth rib in the midaxillary line. She had had pneumonia followed by empyema two years before. The empyema had been treated by a rib resection as the primary operation. Without the trial of irrigations of any kind she had been subjected to an Estlander-Schede operation only a few weeks after the primary operation. This had been followed by several minor procedures at various times during succeeding months, but she was never relieved of her purulent discharge from the chest. She had also practically never been free from fever, and she was about 40 pounds under weight. An examination disclosed the usual anatomic deformity from this type of operation due to an absence, in her case, of all the ribs on the left side from the third to the tenth. In addition, the fistulous tract was found to pass upward and inward for a distance of about 6 inches and to communicate directly with the lung so that irrigations were promptly coughed up into the mouth and tasted. Her vital capacity was only 1,500 c.c, which is only about one half of what it should be for a normal woman of her height (5 feet, 4½ inches). An operation was advised for the purpose of closing the pulmonary fistula, and this was carried out, April 10. The tract was dissected up, for a distance of about 6 inches, to where it entered the lung, ligated and cut off. The stump was then phenolated and inverted into the lung in a similar manner to the handling of an appendix stump. She has apparently been healed since April 15, and she has been entirely free from fever since April 13, the longest time she thinks since her original illness two years before. But despite the fact that she seems healed, her vital capacity is still only about one half of what it should be normally. In other words, she is probably permanently handicapped to such an extent that if she ever again gets pneumonia or any other condition which in itself lowers the vital capacity, she will have only about one-half as good a chance of recovery, other things being equal, as she would have if her vital capacity were normal. The final conclusion concerning the case, therefore, is that probably the mutilating operation was unnecessary in the first place, it has failed to prevent two years of invalidism and it has left her not only with a very bad anatomic deformity but also with a serious physiologic handicap which will probably be permanent.

SUMMARY AND CONCLUSIONS

Determinations of the vital capacity by means of a spirometer, when used in connection with the mathematical expression given in the text, will indicate

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approximately the maximum opening in the chest wall compatible with life, if the mediastinum is not already stabilized by adhesions and induration. If such observations are made before establishing open drainage in cases of empyema or before any thoracic operation, doubtless many lives will be saved. Both theoretical conclusions and actual observations show that in empyema the vital capacity is greatly reduced. That this reduction does not depend merely on the presence of the fluid exudate in the pleural cavity is shown by the fact that an appreciable increase in the vital capacity occurs only gradually after the removal of the exudate. This fact is of importance in being an additional argument against the establishment of an open drainage during the acute pneumonic stage of an empyema when the vital capacity is so low as to approximate the tidal air requirement. Extensive thoracoplastic operations result in apparently a permanent marked reduction in the vital capacity. They should be employed, therefore, only in the rarest instances and only after other methods have been given an intelligent trial for at least many months.

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SURGICAL TREATMENT OF PLEURISY

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Progress in the operative treatment of pleuritic effusions has, until recently, been impeded by the concentration of surgical attention on the cure of empyema. This is an important part of the problem, but only a part, as purulent pleurisy is merely the late stage of some of these affections. The first advance, in the treatment of pleurisy, made about five centuries B. C., was the conversion of a closed into an open pyothorax to start drainage. The second notable step forward, taken some twenty-four centuries later, was the conversion of an open pyothorax into a closed thorax to stop drainage. A third line of progress, started with this latter period, has developed a method of airtight drainage whereby both prophylactic and curative measures can find their simplest application.

Open thoracic drainage was introduced by Hyppocrates, who recognized that simple acute, fetid, or chronic empyema could be idiopathic, traumatic, postpneumonic, or might precede or follow phthisis. He learned that the drain should be placed low, and that open drainage should neither be established too early nor be permitted to proceed too rapidly. Twenty-four hundred years' experience and observation have added very little to these teachings.

Closure of an open pyothorax has always been a serious problem because in a certain proportion of individuals spontaneous healing fails to occur after thoracostomy. No doubt Hippocrates was confronted

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with the identical dilemma, such as a death from amyloid disease, an operative failure or considerable physical and functional disability. There are only three ways healing can be fostered under these conditions: (1) By collapsing the thoracic parietes against the retracted lung through some form of costoplasty, a method with which the names of Estlander and Schede are associated; (2) by releasing the adhesions surrounding the collapsed lung, Delorme's principle of decortication, and thereafter expanding the lung to meet the parietes, and (3) by obliterating the intrapleural space with tissue transplants or by the introduction of some form of synthethic filling compound into this cavity in an attempt to obtain ultimate repair. Each of these methods requires some means of securing adequate tissue disinfection, for instance, excision, lavage or chemical action.

H. I. Bowditch,[1] of Boston, in 1850 began to aspirate and to reaspirate in the treatment of pleuritic effusions. He proved that such treatment was efficacious in combating pleurisy as well as in preventing and in curing empyema. This celebrated internist must be given great credit for having demonstrated the wisdom of treating pleurisy by early airtight one way drainage.

The foregoing summary includes the methods essential in treating pleurisy, if applied so as to cooperate with natural defensive reactions. Pleural resistance is higher when pleural surfaces are in apposition.[2] Such apposition can be maintained or reestablished only when there is adequate pulmonary inflation. Pleuritic effusions are produced more rapidly than they are absorbed, and if they are not removed, pulmonary deflation and pleural separation are inevitable. Drainage is, therefore, positively indi-

1. Bowditch, H. I.: Boston M. & S. J. 140: 572, 1884.
2. Yates, J. L.: Ann. Surg. 71: 241, 1920.

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cated in the early treatment of pleurisy and it must be air-tight one way drainage or pulmonary deflation and pleural separation are again assured.

There is now an abundance of evidence, exemplified in the reports of Whittemore [3] and McKenna [4] to prove that results obtainable by this method of drainage treatment are superior to any yet recorded, if the immediate mortality and the duration of convalescence are considered. In addition there is a more nearly perfect restitution of health through the preservation of the tripod on which functional integrity of respiration depends, namely, free mobility of the thoracic parietes, normal intrapleural negative pressure and unimpaired pulmonary elasticity.

Air-tight one way drainage, whether employed interruptedly by aspiration or constantly by a catheter drain inserted through a rib or between ribs or by a rigid tube sewed into a defect produced by rid resection, has proved efficacious in controlling traumatic pleurisy, including the type following thoracotomy,[5] in reducing the irritations of acute simple pleurisy, and in promoting recovery from empyema either with or without lavage. To this list I can add the control of encapsulated (interlobar) empyema and of tuberculous and carcinomatous pleuritic effusions.

This simple drainage is, however, not a panacea. It will reduce the number of major operations and minimize the severity of those which cannot be avoided, provided it is properly used. The method advocated consists in intercostal insertions by means of a trocar of one or more 16 F catheters, provided with check valves, at the most favorable level for drainage (and lavage) compatible with the patient's comfort, which is determined by possible limits of

3. Whittemore, W.: Boston M. & S. J. **181**: 575, 1919.
4. McKenna: Bull. Chicago Med. Soc. **19**: 22, 1920.
5. Laboratory of Surgical Research, A. E. F., Boston M. & S. J. **180**: 405, 1919.

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activity, whether the individual be bedridden in one position or is able to sit up or even to walk. The force required to expel the exudate and to reestablish normal negative pressure and pulmonary inflation is furnished by the increased intrathoracic pressure of deep inspiration. No strong suction is required though a constant slight negative pressure is often essential to prevent the serous exudate from coagulating within the drainage tube. The tip of the catheter should be introduced far enough to function but not far enough to make avoidable contact with the expanding lung. Such an introduction can be made accurately only under fluroscopic control. The insertion is done under local anesthesia after so dislocating the skin that when the catheter is withdrawn, the skin in resuming its normal position acts like a check valve in closing the drain track. If drainage be required for more than a week, the tubes must be then removed and reinserted at another point or there will be danger of air leakage around the tube, a danger which becomes a certainty a few days later.

If the tubes are improperly inserted through the skin, at the wrong level, or to too great depth and are allowed to remain too long in one position, all of the conceivable misfortunes connected with the most disastrous complications of both closed and open pyothorax can develop. In addition the insertion of a trocar uncontrolled by a fluoroscope can wound the diaphragm, the lung, or even the pericardium. Irrigations, if attempted too early, can disseminate infection or break down limiting adhesions. If given too forcefully, they can cause similar catastrophes or lead to dangerously violent paroxysms of coughing or choking, particularly if the first lavage is not done with salt solution and surgical solution of chlorinated soda, N. N. R. (Dakin's solution), is too irritating. This is certain to be the case if a bronchial fistula is present.

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The invaluable lessons come from failures. All the blunders enumerated in the foregoing have been observed. In a group of empyema patients treated improperly by simple drainage the mortality rate and the proportion of serious complications, especially open pyothorax with a firmly contracted lung, were much higher than they would have been had routine Hippocratic open drainage been employed. It is fair to assert that if principles are given proper attention, methods will take care of themselves. This is true, providing the gross folly of being principle wise and procedure foolish is avoided.

In conclusion there is given a quotation from Bowditch: "It (aspiration or interrupted drainage) has been of infinite service to mankind and will ever continue to be such. It will save lives which without it will be lost. All that is required is that due care govern the use of it."

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RELATIVE VALUE OF VARIOUS OPERATIVE PROCEDURES EMPLOYED IN ACUTE EMPYEMA

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During the last few years many articles on empyema have appeared in the literature, usually consisting of a report of a series of cases with advocacy of a certain method of treatment. The claim is advanced that the particular method advocated is superior to others, and statistics are submitted to substantiate this claim. Some of the articles can be classed as constructive, in that they help in the understanding of the disease and contribute something that will help us better to treat it, while others are merely fads that will be short lived. During this period there has been no contribution that has greatly modified our conception of either the pathogenesis of acute empyema or of the best routine treatment. The period has been marked rather by having certain facts, known before, emphasized and brought forward for discussion. The two most valuable points have been:

1. General recognition of the importance of an acute pneumothorax.

2. The systematic attempts at sterilization of the empyema cavity by means of chemical solutions.

In studying the various empyema reports, one is impressed with the fact that in many of them comparison is made only on the basis of treatment and mortality rate. This is an incomplete and untrustworthy method, for every one who is familiar with the subject knows that cases differ considerably, and that other factors must be taken into consideration.

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Empyema cases should be studied with regard to: (1) the antecedent disease; (2) the type of organism concerned and its virulence; (3) the prevailing climatic conditions; (4) whether cases are sporadic or those of an epidemic; (5) the treatment, and (6) the mortality rate.

That all these factors may play an important rôle was impressed on me in a two years' experience with empyema in various army camps, during which time I had the opportunity to follow several series of cases at different periods, and in different parts of the country, with ample facilities for the study of necropsy material.

In 1919, I reported [1] a series of seventy acute cases, from a Southern camp, with comments on the difference in cases depending on the antecedent disease and organism producing the infection. My article covered the early period of the war, and included the fulminant septic cases following measles. Our total mortality was 27 per cent. Fifty-four of the cases were of pneumococcal origin, with a mortality of 17 per cent., and sixteen of streptococcal origin, with a mortality of 62 per cent. On the basis of this one series, I naturally came to the conclusion that it was chiefly a question of the organism concerned.

Shortly after that, I had occasion to study a series of cases in a Western camp of which by far the larger number were streptococcus cases, with a total mortality of only 6 per cent. Part of this series is included in a report of the influenza and pneumonia epidemic from Camp Custer, compiled under the direction of Lieut.-Col. Ernest E. Irons, by Major Lynn S. Beals, Capt. Wyndham B. Blanton and Capt. John F. Bresnahan; it gives the interesting figures reproduced in Table 1.

1. Eggers, Carl: Empyema: Analysis of Seventy Cases at Base Hospital, Camp Jackson, South Carolina, Surg., Gynec. & Obst. **28**: 348 (April) 1919.

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TABLE 1.—ORGANISMS CONCERNED IN WESTERN CASES

			Cases	Deaths
Sterile fluids			25	
Empyema:				
Streptococcus hemolyticus			42	3
Streptococcus viridans			9	
Streptococcus undetermined			2	
Pneumococcus Type I	7		53	1
Pneumococcus Type II	0			
Pneumococcus Type III	5			
Pneumococcus Type IV	5		17	
Thick pus, no bacteria			2	72
			72	97 4

What explanation for this can one offer? Had the treatment been different, one might attribute it to that; but it was exactly the same as that advocated and carried out in the latter part of the period covered by my paper, namely, repeated aspirations until the pneumonia had subsided and pus had formed, and then intercostal incision or rib resection.

One is compelled to assume that though the organism in these cases was also a hemolytic streptococcus, it was not the same virulent organism that caused the fulminant septic cases associated with measles in the winter of 1917-1918. Similar observations can no doubt be cited by other observers; they simply emphasize how misleading it is to draw definite conclusions from one group of cases.

In another series of twenty-nine cases, representing all the empyema cases of an influenza epidemic in a Southern camp, there was a mortality of eight, or 27.6 per cent. They are divided as in Table 2.

TABLE 2.—ORGANISMS CONCERNED IN SOUTHERN CASES

	Cases	Deaths
Streptococcus hemolyticus	10	4
Pneumococcus Type I	3	0
Pneumococcus Type II	2	0
Pneumococcus Type III	6	1
Pneumococcus Type IV	4	0
Staphylococcus aureus	4	3
	29	8

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Necropsies, performed in six of the eight fatal cases, disclosed:

CASE 1.—*Streptococcus hemolyticus;* left, complete empyema; bilateral bronchopneumonia; suppurative pericarditis, and vegetative endocarditis.

CASE 2.—*Streptococcus hemolyticus* and pneumococcus Type I; bronchopnuemonia; purulent pericarditis, and bilateral empyema.

CASE 3.—*Streptococcus hemolyticus;* right empyema; purulent pericarditis; bronchopneumonia, and serofibrinous peritonitis.

CASE 4.—*Streptococcus hemolyticus;* left pyopneumothorax: an abscess of the right upper lobe; bilateral bronchopneumonia, and pericarditis.

CASE 5.—*Staphylococcus aureus;* bilateral empyema; pericarditis, and vegetative endocarditis.

CASE 6.—*Staphylococcus aureus;* left empyema; lobar pneumonia; fibrinous pleurisy, and pericarditis.

These findings demonstrate conclusively that probably no method of treatment known at present could have saved the patients. The cure for these septic cases is to be looked for, not from surgery, but from serum treatment.

In the one pneumococcus case that was fatal, no necropsy was obtained. The man had been extremely sick, and had had a bilateral pneumonia and empyema and a positive blood culture with Type III pneumococcus. His death was predicted by the medical service on the strength of laboratory findings, before an operation was performed.

The eighth patient who died, in one of the staphylococcus cases, was in a septic state with ear complications and acute dilatation of the stomach. Not one of the patients died of an uncomplicated empyema, and not only those who died but also many of those who recovered were extremely sick, and careful individual treatment alone made it possible to keep the mortality rate so low. To compare such a series with the type of empyema cases ordinarily encountered only on a treatment and mortality basis is manifestly not possible.

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We must recognize that there is a difference in cases, and that those of an epidemic are usually more virulent than sporadic cases.

THE NATURE OF EMPYEMA

This leads to a consideration of what empyema really is. The general conception is that it is a collection of pus in the pleural cavity more or less encapsulated and usually following pneumonia. Had we in the army been confronted with this type alone, very little discussion would probably have arisen. But with the incidence of measles and influenza in our army camps, complicated with a severe bronchopneumonia bilateral in character and often associated with profuse exudation into the serous cavities, a clinical picture was presented that was unfamiliar to many of the surgeons who were suddenly called on to treat large numbers of these patients.

On the theory that all infected fluid in the thorax was a potential empyema, prompt operation was resorted to, with unfortunate results in many instances. Various attempts to reduce the mortality followed. It was chiefly in two directions that a remedy was sought:

1. One group of operators who considered the presence of any infected fluid within the thorax an empyema, and who thought its immediate removal of primary importance regardless of the stage of the pneumonia, developed a technic that would give drainage and at the same time prevent an acute pneumothorax.

2. The other group, led by experience to the conviction that in the majority of cases the fluid present in the course of a pneumonia, even if infected, was not of primary importance, delayed operation until the pneumonia had subsided and adhesions formed to wall off the fluid, and in the meantime resorted to aspirations.

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In the group of seventy cases mentioned before, I made various observations. One was that empyema following a primary lobar pneumonia was likely to be different from empyema following a bronchopneumonia secondary to some other acute infectious disease, such as measles or influenza. Another observation was that empyema of pneumococcal origin was different from the early streptococcus empyema. The inflammation of the pleura associated with a pneumococcus lobar pneumonia is usually limited to the involved lobe. It is due to direct extension of the infectious exudative process in the lung to the overlying pleura. There is no rupture of a subpleural abscess; as a matter of fact, no abscess formation takes place in the lung. The pneumonia has usually subsided when the empyema becomes fully developed, and complete restitution of the lung to normal takes place. The pleural exudate early consists of thick pus well encapsulated.

If, on the other hand, we deal with a streptococcus or staphylococcus infection, we usually find a bronchopneumonia bilateral in character and frequently associated with multiple abscess formation in the lungs. Wherever a patch of pneumonia appears close to the surface, the overlying pleura may become involved. A profuse serous exudation develops and this extensive exudate may become infected.

Occasionally a small subpleural abscess may rupture and be responsible for the empyema, but this is probably the exception instead of the rule. At times we have incontrovertible evidence that such a rupture has occurred and that is in the cases of pyopneumothorax. Some of the patients that take the Dakin treatment poorly may also belong to this class, but the total of such cases is small—certainly not sufficient to warrant the statement that all empyema cases are due to rupture of a subpleural abscess. The latter would not explain the appearance of a suppurative inflammation in the pericardium or the peritoneum that occasionally

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are coincident with the pneumonia and the empyema. The fact that a clear serous exudate containing streptococci often exists for days would speak against rupture of an abscess. Had an abscess ruptured, the fluid would at once take on the characteristics of pus, as it does in patients with a pyopneumothorax.

We have to consider these cases as general streptococcus or staphylococcus infections, with localization in the lungs and serous membranes. The many suppurative complications in other parts of the body would substantiate this view. The pneumonia in these cases often runs a long course, affecting one part of the lung after another, and the fluid may remain serous for some time before it changes to actual pus.

METHODS OF TREATMENT

Aspiration.—When speaking of the treatment of acute empyema by repeated aspirations, one does not intend continuing aspirations until a cure results or even "as long as possible." A fixed objective is followed, namely, to rid the body of an infected fluid early in the course of pneumonia until the process in the lungs has subsided and the fluid been walled off. As soon as this stage is reached, an operation should be performed. Aspiration is a simple procedure, and the best apparatus to be employed is the Potain aspirator. The needle should be introduced to just within the thoracic cavity, to avoid injuring the lung. All the fluid may be removed, or just enough of it to give relief from respiratory distress, depending on the case. With proper technic, the introduction of air is effectively prevented. Aspiration gives great relief in acute cases, and should be freely employed until a patient is ready for operation. As a curative measure it is of little value, for we are dealing with an inflamed, infected pleural membrane that will continue to secrete. Occasionally, however, a cure does result, as several authors have reported. I have had under treatment

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two cases, one with a streptococcus, the other with a pneumococcus culture, that cleared up after one complete aspiration.

Open Methods.—The two paths available are the intercostal incision or the resection of a portion of a rib. In either event a drainage tube is inserted and the pus given free exit. These are the oldest methods in use, and in the past they have given satisfactory results. Have they failed in their usefulness since empyema has attracted so much attention? They certainly give good and ample drainage, which is continuous and easily maintained. The operation may be performed under local anesthesia, either at a hospital or at home. Little or no embarrassment of respiration results; on the contrary, breathing becomes easier, with free drainage of the infected material and subsequent diminished absorption. Drainage can be instituted wherever it is demanded, i. e., wherever the pus is found. The patient may be out of bed as soon as his general condition permits, and his position in bed may be changed as desired and as is compatible with his comfort.

No special appliance or apparatus is required, for a drainage tube is easily procured or improvised, and altogether the operation is so simple that many a life has been saved by a practical physician who, at the right time, instituted open drainage.

The after-treatment is usually very simple, and an assistant or nurse may be entrusted with it. If irrigation, or especially if Carrel-Dakin treatment is used, more care is required, for the details of treatment must be carried out as advocated. With an empyema drained at the proper place, early healing is favored by keeping the cavity empty, sterilizing it, and preventing damming back of pus. The lung will gradually expand, the formation of a thick disabling pleura will be prevented, and as a result the danger of recurrence is minimized.

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What, then, is the objection to the operation? Does it invite complications, or does it not effectively avoid dangers? In the ordinary empyema cases, in which the pneumonia has subsided and the fluid become pus, there is no danger connected with the operation if ordinary surgical principles are observed. No special skill is required to make an intercostal incision or to resect a small piece of rib under local anesthesia.

All steps are performed under guidance of the eye, bleeding is easily controlled, pus and fibrin clots can be evacuated, and drainage can then be instituted. An acute pneumothorax does not result because the pus has become walled off before the operation is performed.

Closed Methods.—These may be divided into two main groups: (*a*) intermittent and (*b*) continuous closed drainage. In each group there are numerous subdivisions based on special appliances or procedures advocated by individual authors. Though these methods have been used for years, they have never been universally adopted as routine operations. The reason for this is that they have failed in certain important respects, the chief of which are inadequate drainage and inability to dispose of large fibrin clots. Cumbersomeness and easy derangement of apparatus are other objections raised to it, but all of them have been and can be successfully met in a case in which the method is really indicated.

Perhaps the chief argument against the general adoption of closed drainage is that it is unnecessary, and that it often delays rather than favors early healing. Some of the closed methods are easily applied; others are more difficult and require special skill. Practically all of them necessitate the use of some special appliance or special treatment to be effective.

The after-treatment needs constant supervision by one familiar with all the details, and who understands and values the importance of an acute pneumothorax.

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An error in technic may negative all that the treatment was instituted to prevent.

Some of the advocates of closed drainage state that it is of minor importance where the puncture is made, as long as the tube enters the cavity. It is claimed that suction will remove all secretions effectively. Such teaching is misleading, because in the upright position sacculation of pus may occur. Healing will often be delayed because drainage is not free and secondary accumulations of pus are more likely.

We have observed that a chronic pneumothorax may result in spite of the treatment, and that an already existing pneumothorax is not obliterated by the application of negative pressure.

It appears that with a trocar stab a lung puncture results more often than with other methods. One author reports bronchial communication in ten cases in a series of thirty-two. This is much more frequent than ordinarily encountered.

There is one method of treatment I want to refer to particularly, namely, the injection of formaldehyd glycerin into the cavity after aspiration. The injection of this fluid inhibits the growth of bacteria, but it forms a more or less complete cast of the cavity and gives rise to a very thick abscess wall which is quite disabling. Though the organisms do not grow on culture, they constitute a menace to the patient, and he is more or less invalided. Twenty-one cases of this character came under my treatment at one time, and it was necessary to perform a secondary operation in seventeen of them. In several of these, simple open drainage, followed by Dakin treatment, was sufficient to bring about a cure, while in the others a radical operation had to be performed.

Bearing in mind the advantages and disadvantages of closed drainage, one may use it in properly selected cases. Excellent results have been reported by a number of authors.

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Closed drainage finds its greatest application in those septic cases in which, early in a pneumonia, the presence of the fluid itself is considered a menace to the patient. It is here used to bridge over the critical period until the pneumonia has subsided and adhesions have formed. A secondary drainage operation may be performed later. Closed drainage is also invaluable in cases with a double empyema and in patients with a pyopneumothorax.

STUDY OF CHRONIC CASES AND WHAT THEY HAVE TAUGHT

The causes of chronic empyema cavity may be classed as (*a*) avoidable and (*b*) unavoidable. We need not discuss the unavoidable causes, because the treatment of acute empyema has no bearing on them. Of the avoidable causes the most common is inadequate drainage through a narrow sinus, allowing damming back of pus, repeated reinfection of the cavity, and the development of a thick, unyielding pleura.

The next most frequent cause is an improperly placed drainage opening, one not at the dependent part of the cavity.

Another common cause is too early operation, allowing the lung to collapse at a time when no adhesions or only a few have formed.

All these causes argue for delay in operating until the pneumonia has subsided and the fluid has been walled off. Once this stage has been reached good drainage should be established, usually at the classical site, and Dakin-Carrel treatment then instituted.

SUGGESTED TREATMENT

There exists at present some confusion regarding the best routine method of procedure in acute empyema. The proper treatment of empyema, in all its phases, requires a knowledge and an appreciation of the physiology of normal respiration and also of the

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variations in the presence of disease. No one method will always give uniformly good results, and no attempt should be made to make a case fit a given method of treatment. On the contrary, that treatment which will most likely restore the patient to health in the shortest time should be adopted in each case. Individualization is the keynote of the successful treatment of empyema, and clinical experience and observations made at the necropsy table must guide us in the right direction. From these observations we have learned that there is such a thing as a common type of empyema, following pneumococcus pneumonia, in which the pus collects in the lower part of the chest. It becomes walled off early and the costopleural angle becomes obliterated by adhesion of the diaphragm to the chest wall. Intercostal incision in the eighth or ninth space or the resection of a portion of the eighth or ninth rib will place the drainage at the dependent part of the cavity.

Simple open drainage or the addition of irrigations, preferably with surgical solution of chlorinated soda (Dakin solution), constitutes the after-treatment. By far the larger number of all empyema cases conform to this type.

Taking this as a basis, one may modify the treatment as indicated in a given case. If there is an unusually large amount of fluid, as is so often found in the septic streptococcus or staphylococcus cases, and it is considered that the presence and absorption of this fluid itself, regardless of the stage of the pneumonia, is dangerous to the patient, one of two courses may be followed.

1. The fluid may be aspirated, and this may be repeated as often as the thorax refills, until the pneumonia has subsided. Coincident with resolution, the fluid has usually become pus and has become walled off. A simple drainage opening may then be made, as advocated above, and the case treated the same as a pneumococcus empyema.

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2. If more urgent treatment is demanded, one may make a small intercostal incision, introduce a drainage tube, close the tissues around it, and then lead the tube into a partly filled bottle under the bed. This gives a closed method of drainage. A Brewer tube may be used for this purpose, or an ordinary rubber tube sutured to the edges of the wound. Good drainage with little respiratory disturbance will be obtained. The tube fits snugly for from five to seven days, and at the end of that time the treatment can safely be converted into an open one, because by that time sufficient adhesions will have formed to prevent a pneumothorax.

Occasionally the bottle system of drainage with negative pressure, as advocated by the Empyema Commission, can be used to advantage. It permits the introduction of Dakin's solution, with flushing of the cavity while drainage is going on. However, suction should not be employed while the inflammation in the lung is active. It will not draw out a lung filled with inflammatory exudate, and if it could, it would be harmful. An inflamed organ should be put at rest. To employ suction after the inflammation has subsided is unnecessary, for the secret of healing is not suction but sterility. This sterility is best obtained by open drainage, perhaps favored by irrigation with antiseptic solutions. I believe that the only safe healing for an empyema is by obliteration of the cavity. The two opposing layers should adhere, and they will adhere just as soon as the surfaces are sterile. For this reason I believe the catheter method of drainage as a routine method, advocated by several authors, is not going to prove satisfactory. Stab wounds of abscesses with subsequent cupping by means of Bier cups, at one time so much lauded, has been given up for the same reason, that it also affords inadequate drainage. When pus is present we must follow the oldest rule in surgery and give it free exit.

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ABSTRACT OF DISCUSSION

ON PAPERS OF DRS. GRAHAM AND EGGERS

DR. ALEXANDER LAMBERT, New York: A physician cannot discuss with surgeons the wisdom of proceeding with this or that mechanical method of empyema. He could discuss very pertinently the wisdom of getting house staffs together and seeing that empyema cases in the medical ward are quickly reported to the visiting surgeon and not to the house surgeon. That will do more good to save these patients than anything I have yet found. Empyema is not, as a rule, a sequel of pneumonia; it is a complication appearing, as a rule, on the fourth or fifth day. Bronchopneumonias are not always streptococcal in character. They vary in pathogenesis and in the kind of germ causing them. One great difficulty has been well pointed out by Dr. Eggers, and that is, that the pneumonia causes more deaths in the early stages of empyema than does the empyema, because it prevents recourse to surgery. The pneumonia must subside before it is safe to operate, and the old idea whether the pus is laudable or damnable makes no difference. It is a question of the activity of the pneumonia. Moreover, in the present influenza, there is as much danger from minute abscesses of the lung as from empyema. I think I lost six or eight patients from multiple abscesses scattered over both lungs. In cases of one large abscess of the lung we succeeded in saving 60 per cent. of our patients. Moreover, an important question which few think of in connection with the physiology of the lack of breathing space is that when the lung starts to collapse it does not collapse straight up from base to apex. After the lower part is collapsed it holds by the root and swings so that an entire collapse of the lung is against the mediastinum. This is not usually realized. In all cases of complete collapse of the lung, a sausage-shaped lung is lying against the mediastinum. Surgeons should teach that inserting a trocar into a lung cavity in pleurisy is a trauma and more liable than anything else to produce empyema; to do aspirations in the early stages of pneumonia, and to refer the patient to the surgeon as soon as the pneumonia has subsided. Next to pneumonia, the most frequent cause of empyema is from the traumatism done by a dirty needle.

DR. MARTIN B. TINKER, Ithaca, N. Y.: Attention has been called to the slight progress which has been made in the treatment of pleurisy and infectious effusions from the time of Hippocrates until the time of the great war. We have accumulated a great deal of valuable experience and it is highly important that we should get the lessons of this experience thoroughly. It was demonstrated abundantly that early operation in empyema and purulent effusions produced a large number of deaths. At first we resected a rib and evacuated the pus in all cases. The death rate was so high that we

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realized we must resort to some other method. We aspirated until in many cases the fluid became so thick it would not come through the canula. Then we diluted the pus with salt solution and finally when it became too thick to aspirate, we resected the rib. The mortality was reduced from over 60 per cent. to 22 per cent. In these cases the antecedent infection is of great importance. No doubt the empyema due to the pneumococcus should be handled differently from empyemas due to the streptococcus, especially the hemolytic streptococcus. Dr. Eggers called attention to the fact that in many cases pleura, peritoneum and pericardium were affected, and with such multiple infection of serous cavities it is hardly to be expected that the patients will recover by any means of treatment. Aspiration and cannula treatment is not always successful. I believe that the use of the cannula and aspiration will cure a considerable percentage of cases, but as Dr. Eggers emphasized, it is going to be necessary to resect a rib and drain in many cases. There is nothing gained in most of these cases in taking out more than one rib. If one rib is resected and the cavity is thoroughly sterilized by surgical solution of chlorinated soda the majority of patients will recover without any more extensive operation. Extensive thoracoplastic operations are unnecessary, except in very unusual cases. Dr. George R. Fowler, of Brooklyn, called attention to decortication of the lung as a means of handling these chronic empyema cases five years before Delorme did so.

Dr. Arvine E. Mozingo, Indianapolis: The open thoracotomy has high mortality, inertia of custom and prestige of surgical tradition. I developed an improved technic for a closed method and had but two deaths in 138 cases, 45 acute and 93 chronic. The operation is simple and success depends largely on after-treatment. One author recently reported a series of 410 cases with forty-eight deaths following open operation, and 100 deaths in cases he considered unsuitable risks for any operation other than aspiration. While repeated aspirations are no doubt advisable before the open operation is done, aspiration is very unnecessary with the closed method. The statement made by Dr. Eggers that the twenty-one transfers were aspiration cases treated with formaldehyd-glycerin is not correct. Thirteen patients had been operated on overseas by the open method, one by Phillip's, four by Diederich's and three by my method. One of my patients was permanently healed, one had been operated on but two weeks previously and the other was a bilateral case with persistent bronchial fistula.

Dr. James F. Mitchell, Washington, D. C.: Controversy between the open and closed methods of treating empyema is unnecessary. Both methods are good, each in its place, and we should learn to think of empyema not as a single condi-

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tion to which all our attention should be devoted, but as only part of a more general condition. In this way we can, as Dr. Eggers suggested, select the treatment according to the stage of the condition. We are now getting together an enormous amount of material through the surgeon general's department of the army, which will afford enlightenment on the whole subject of empyema. Dr. Edward K. Dunham, of New York, is tabulating the complete records of 4,000 cases treated in the Army epidemic, and this brings out some very interesting facts. Dr. Dunham sums the thing up in a sentence. In a letter to me he says: "Two points, however, are very simple: (1) that in fatal cases there are associated foci of infection within the thorax and in other parts that in themselves are so serious that they menace life; (2) that there is a critical period in these severe cases that lasts several days—say, up to three weeks—during which the single empyema is of relatively small account, succeeded by a period in which that empyema becomes the main problem for treatment." The lessons are: In the first period, save life (if you can); in the second period, reduce the period of convalescence and minimize the final disability. "On these two commandments hang all the laws and *profits*." The experience of the Empyema Commission verifies practically what Dr. Eggers said that you must select a time for operation and fit the operation to the time and carry out the commandments of Major Dunham; in the first few days save life, later reduce the period of convalescence and minimize deformity.

Dr. Moses Behrend, Philadelphia: The bacteriologic control of these cases is probably the most important point brought out. In all cases of *Streptococcus hemolyticus* infection, no extensive operation should be performed. A simple aspiration should be done until the acute symptoms subside. In all streptococcus, staphylococcus and pneumococcus infections, when pus has formed, the sooner we get it out the better and the best operation is rib resection. A great deal of harm has been done by these other operations, such as thoracotomy, introduction of trocar or cannula and simple drainage tubes. I do not think they have any place in the treatment of this disease when pus has once formed and acute symptoms have subsided. Dr. Eggers has brought out well that the only way to remove pus from any part of the body is by drainage, and the only proper way to treat an empyema is by excision of ribs.

Dr. C. D. Lockwood, Pasadena, Calif.: I have had no experience on the experimental side of chest surgery, but I have had considerable experience in traumatic surgery in front line hospitals. Practically, we seldom met with the condition Dr. Graham speaks of, i. e., extreme asphyxia, even when we produced a large pneumothorax. The most important lesson gained from our experience in the Army is that we can apply the same principles in surgery of the chest that

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we do to other portions of the body in civil life. At Brest I saw many of the early cases of influenza contracted during transit. We soon learned that these patients died if drainage was done early. We used early aspiration and injected 2 per cent. liquor formaldehydi in glycerin even before the recommendation of the Empyema Commission in this country. I agree with Dr. Eggers that we cannot determine the value of any method of treatment in a single series of cases. Each case is a law unto itself. Another important factor has not been mentioned in this discussion—the routine use of the roentgen ray in connection with drainage of the pleural cavity.

Dr. George J. Heuer, Baltimore: Owing to Dr. Graham's failure to be more explicit in his statements, there has arisen some confusion as to the practical application of his work in intrathoracic surgery. In conversation with surgeons interested in thoracic surgery I have heard it stated that Dr. Graham's work is a positive proof of the necessity of pressure anesthesia in operations on the thorax because the operative opening in the thorax is greater than that found by Dr. Graham to be compatible with life. It was our experience abroad in treating wounds of the thorax that the chest may be opened very widely without causing respiratory upsets; and that regardless of the intrathoracic pressure relationships or the degree of collapse of the lung in the opened and unopened sides, respiration was sufficient for the patient during the period of an operation if the lung on the unopened side was normal. Obviously, the best way to treat chronic empyema is to prevent its occurrence. Our experience has shown that if we keep patients in the hospital a little longer we can effect a cure in every case of acute empyema. When, however, patients come to the hospital with chronic empyema, we should rather direct our efforts to sterilizing the cavity than to obliterating it by rib resections. In our experience with twenty-four cases of chronic empyema, these sterile intrapleural cavities have remained unobliterated for a variable time after the operative or spontaneous closure of the sinus tracts, but eventually have been spontaneously obliterated. In no instance has the unobliterated intrapleural cavity been an inconvenience to the patient. We can, therefore, disregard the cavity if we can sterilize it; and our efforts should primarily be directed toward the sterilization of chronic empyemic cavities.

Dr. Carl A. Hedblom, Rochester, Minn.: During the last two years we have treated 150 cases of chronic empyema at the Mayo Clinic. Dr. Eggers pointed out very rightly that the treatment of acute empyema should be adapted to the patient, and that the particular operation the surgeon favors should not be used regardless of the special features of the case. Forty-two of our patients were cured or materially improved by simple drainage. In fifty-one cases, cavities were obliterated or nearly so by irrigation with surgical

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solution of chlorinated soda. Some of these were instances of practically complete collapse of the lung. There remained a group of cases of relatively long duration, in which neither rib resection for efficient drainage nor the irrigation sufficed. In thirty such cases a decortication was done, after preliminary sterilization. There remained twenty-seven cases in which it was necessary as a last resort to do a plastic operation, involving sacrificing a considerable portion of the chest wall. Dr. Graham mentioned one of the chief objections to an extensive plastic operation on the chest wall—namely, the greatly lowered vital capacity that may result. The main object should be to get the patient well, without avoidable loss of function. In my opinion, an avoidable mutilating operation, involving a considerably increased mortality is not justifiable for the sake of shortening convalescence. If every other means has failed, then radical destructive operation may be advisable. There were four deaths in this series of 150 cases.

Dr. H. M. Richter, Chicago: Dr. Graham made a serious error in comparing the respiratory movement of the dog with that of the human being. The transverse diameter of the chest of the human being is twice that of the anteroposterior diameter. The dog's is only half as much. The area of the diaphragm as compared with the transverse diameter of the two chests is tremendously different. The lateral motion of the median septum of the human chest—which is trifling compared with the capacity of each side of the chest—as compared with the lateral motion of the median septum of the dog's chest, is such that when one opens the dog's chest one immediately reduces tremendously the vital capacity, but when one opens one side of the human chest one diminishes the capacity to but a trifling degree. I think it is because of this that the modern transthoracic operations have been so much more successful than in former days, for instead of a small intercostal incision one is made that enables one adequately to explore and to do what should be done. We have been so long taught to drain pus where we find it, to make free incision for pus that needs drainage, that we forget that the pleura is not a large cavity. It is a trifling cavity. When the two layers of the pleura are in contact we have nothing but a capillary space which holds but a centimeter of fluid. In empyema we convert that trifling space into a tremendous space. We are at first impelled to make free incision to drain that large cavity. The fact is that any means which tends to bring the lung out to the chest wall immediately converts that large cavity of the empyema into the small normal cavity of the pleura and then there is need for only trifling drainage. I do not refer to the many exceptions to the rule, such as the old rigid lung that cannot be brought out, or masses of fibrin that cannot come through a small tube. The logical

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thing is to carry out such a method of suction treatment as will quickly bring together the two layers of the pleura.

Dr. T. Turner Thomas, Philadelphia: Dr. Eggers said first that the drainage opening should be in the dependent position, and, then, that it should be in the eighth or ninth interspace. He said also that the costophrenic sinus in these cases was obliterated by adhesions. I have been emphasizing during the last eight or ten years a method used years ago by the elder Ashhurst. This consists essentially in the introduction of a grooved director curved at the end; or a similar instrument, such as a urethral sound, at a safe level, i. e., high enough, where we know we shall find pus and not injure the diaphragm. The tip of this exploring instrument is then turned downward to the bottom of the empyemic cavity, where it can easily be felt through an intercostal space, and an opening then safely made on it at the bottom of the pus cavity. A piece of the rib just above may then be excised or not, as desired, a good sized rubber tube being inserted for drainage. I have thus placed the opening usually in the eleventh interspace. I have placed my finger at the bottom of the costophrenic sinus in almost, if not every, case and have found it not obliterated by adhesions, but widely distended by the pus. It has proved to be a very simple and safe operation requiring not more than four or five minutes after the first exploratory opening is made. Sometimes the lowest part of the empyema will be in the tenth interspace, much more often in the eleventh, but always at the bottom of the cavity.

Dr. Rosalie Slaughter Morton, New York: A point not emphasized is the relative effects of gas gangrene following chest wounds and those of other parts of the body. It is never so serious, either from the standpoint of pain or of fatality, in the chest as where muscular tissue which is confined is wounded, as, for instance, in the bottle shaped wounds of the leg and thigh the result of necrosis of muscle fiber due to the pressure of gas which formed there quickly and caused a rapidly resulting septicemia. The pressure caused a great deal of pain. Ripping these wounds open was the first step in their treatment. As the chest wounds were usually gaping, the pressure effects were not serious, and mortality was little increased by this complication, whereas in small wounds of the leg the mortality was high.

Dr. John B. Haeberlin, Chicago: In reference to the technic of advanced empyemas or neglected empyemas, those that are seen late, the object is to drain the chest cavity with the minimum amount of shock or reaction to the patient. Whenever possible do a rib resection. Get the pus out without unnecessary manipulation. If you place a sterile piece of gutta percha, 10 by 10 inches, over the chest immediately after the operation is completed, you will find that with each positive phase the empyema sac will drain itself and the gutta

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percha will hold the air that wants to be aspirated, so in that way we are able in extreme cases to do our work quickly and accurately and yet avoid the annoyance and irritation of drainage tube and gauze. The patient will be extremely comfortable after being put to bed. Redressings are not painful. Dress for from six to nine days until you want to use tube or gauze. The change is made by applying sterile oil and slipping out the gutta percha with a fresh piece lying over it.

Dr. Evarts A. Graham, St. Louis: As to whether a positive or negative pressure apparatus is absolutely essential in the performance of intrathoracic operations, I do not think so. The work of which I have spoken has shown clearly that there is no definite physiologic necessity for using intratracheal insufflation or any cumbersome negative pressure apparatus, at least in the majority of cases which demand intrathoracic operations. If the man of average vital capacity can withstand a free opening in his chest wall of ten square inches, it is clear that for such a case no artificial means of maintaining respiration will be required during the operation. For as a matter of fact, it is very seldom necessary to maintain a free operative opening of so great an area, and usually the operative opening is actually much less than it seems to be because of the presence in the incision of fingers of the operator and his assistants, gauze pads and sponges, instruments and frequently a lung which has been delivered, all factors which tend to reduce very markedly the actual free area for the admission of air into the pleural cavity. It should be emphasized again, however, that there are conditions in which the vital capacity is so reduced, as, for example, in pneumonia, that compensation cannot be made for an opening of any size. I cannot see the importance of the shape of the chest, and I cannot understand how it could make any difference whether the chest is cuboidal, spherical, or polyhedral, or what the anteroposterior diameter happened to be. In order to breathe, it is necessary only for negative pressure to be established at some time during the respiratory act so that the lungs will be inflated sufficiently to obtain the tidal air. This is accomplished ordinarily by the fact that the respiratory muscles suddenly increase the size of the thorax. The sudden increase in size necessarily reduces the pressure of the interior, and air rushes into the lungs. If you have either a cube or a sphere containing air and suddenly increase its size, the pressure within obviously will be reduced until enough air has entered from the outside to make up for the increase of volume. When an opening is made into the chest wall, with the free admission of air, the ordinary response is an increase in the amplitude of the respiratory movements, or, in other words, an increase in the size of the thorax. If the opening is a small one, it is possible by a sudden increase in size of the thoracic cavity to reduce the intrapleural pressure sufficiently to enable the lungs to obtain the tidal air,

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because of the relatively slow entrance of air through a small thoracic opening. But, if the opening is sufficiently large, so much air will enter the pleural cavity with each inspiration that it will be impossible to establish a negative intrapleural pressure because the expansibility of the thorax is limited. Obviously, if negative intrapleural pressure cannot be established, the lungs cannot be inflated and respiration will cease. It seems to me that the explanation which I have offered is the only one which can explain the striking fact noted in the war that large wounds may be made in the chest wall without a necessarily fatal result. On the basis of this explanation, there is nothing surprising about the facts observed in the war. Unfortunately, at the time I published my first article I understated the maximum nonfatal opening of the chest wall in an average sized normal man because I had the impression from available textbooks of physiology that 3,700 c.c represented the average vital capacity in men. Subsequent information on the value of the vital capacity showed that the maximum nonfatal opening of the chest wall in the average man must be larger than originally stated.

DR. JOHN L. YATES, Milwaukee: As suggested both by Dr. Mitchell and Dr. Heuer, it is most desirable to prevent the development of chronic empyema. My argument is that the surest method of prevention is to arrest the process in the stage of acute serous pleurisy before acute empyema has developed. It must be recognized that the pleura reacts primarily in the same way to all irritants, and that differences in later reactions are not of necessity specific for any microorganism, but are due to variations in the intensity and duration of irritation as well as its character. If irritated visceral pleura be maintained in contact with the parietal pleura, fibrinous adhesions obliterating the pleura cavity are inevitable and empyema becomes impossible. Some day purulent pleurisy will be regarded as purulent peritonitis is now considered—a confession of therapeutic failure. Diagnostic methods for the prompt recognition of acute serous pleurisy will be developed. The institution of continuous automatic airtight drainage at this time is required. It is easily and simply done and without any cumbersome or expensive apparatus. From observations made as to the plan pursued by various operators, it was apparent that some men preferred to use differential pressure and some did not; some preferred primary one-way drainage and some did not. The greatest advances to be made in thoracic surgery are to come through the prevention of empyema. The positive pressure gas-oxygen analgesia, devised by Gwathmey, and primary air-tight one-way drainage are going to make thoracotomy a feasible, safe operation, because they give the greatest protection against purulent pleurisy.

DR. CARL EGGERS, New York: No treatment of empyema is always the best. In the majority of cases, if actual pus is present, open drainage will give the best results. If we are

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dealing with a thin fluid, containing streptococci, it is best to delay open operation until pus has formed, and in the meantime use aspiration or some form of closed drainage. Empyema must be considered a serious condition, and if we are confronted with a patient with acute empyema we have to take into consideration all the factors pertaining to that case and then make up our mind what is best to do. I do not believe that empyema always starts as a simple pleurisy. I believe that in the majority of cases the fluid is infected from the beginning. All the streptococcus cases I have seen have had organisms at the first aspiration even though the fluid was still clear. I believe Dr. Mozingo's method of treatment is of value in certain forms of acute empyema, just as other closed methods are. In the cases we received from him, however, it was apparently not of much value. Some of the patients were classed as cured, but they had pain and dyspnea and the roentgen ray showed a well defined cavity filled with pus. Aspiration demonstrated pus filled with organisms, though the culture was negative. I could not consider such a patient cured. I do not believe an empyema patient is cured until all the fluid has disappeared and the cavity been obliterated.

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